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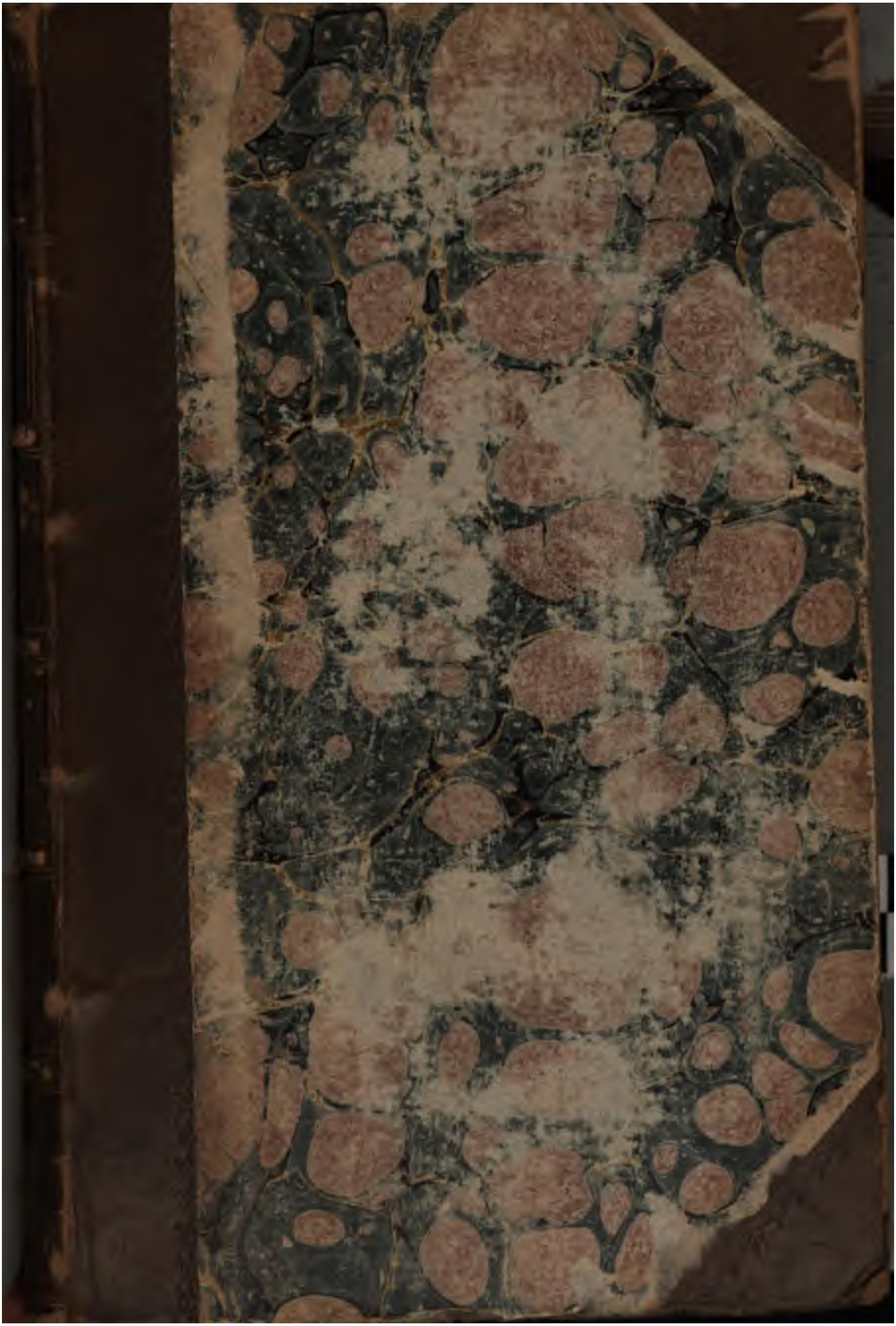

ELEMENTS OF ANATOMY

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J. 1818.

ELEMENTS

OF

DESCRIPTIVE AND PRACTICAL ANATOMY:

FOR THE USE OF STUDENTS.

BY

JONES QUAIN, A.B. M.B.

MEMBER OF THE ROYAL COLLEGE OF SURGEONS, AND ONE OF THE
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> *Quicumque omnia perpendit, quæ in Medicinâ se offerunt cognoscenda, videbit facilè quod primum omnium eorum, quæ discere debet, sit* Anatomé........*Omnes enim Medici ferè conveniunt incipiendum esse in studio Medico propriè dicto, ab illâ scientiâ, sine quâ nihil potest Medicus, et omnia tantum tumultuarié agit.*
>
> Boerhaave, Methodus Discendi Medicinam.

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1828.

477.

PREFACE.

In the composition of the subjoined work the author has kept the following objects constantly in view :—

To give a condensed and methodical description of the different structures and organs which enter into the composition of the human body ;—

To point out the most convenient methods of conducting their anatomical examination ;—

To indicate some of the more important practical applications that may be made of the facts disclosed to the student during the progress of his inquiries ;—

And, finally, to present abridged summaries of the most instructive principles of general Anatomy.

The attention of students, during the limited period of their public education, is necessarily divided between a variety of objects. They have to pass through the whole circle of Medical Science, and to attain a competent knowledge of the different departments into which it is divided,—so that each can receive but a limited portion of attention. It generally happens that the earlier essays of a student in Practical Anatomy teach little, save a negative knowledge;—they teach him how he ought not to proceed, and his own ingenuity, limited as his experience is, must be taxed to determine how he should conduct the examination of a similar part at a future period. The effort is again made, no doubt with a certain degree of improvement, but it is necessarily slow and tedious. To lessen, if not altogether to remove, this source of difficulty, the author has deemed it advisable to indicate how the first incisions through the skin should be made when the examination of each region is about to be commenced, and also to note the parts which lie, layer after layer, beneath the skin, and how they ought to be displaced and removed. This may be termed the enchiræsis of the art; and though it can be acquired only by practice, the time and labour necessary for its acquisition may be considerably abridged by following such rules as are embodied in this book. The precepts here alluded to will be found at the conclusion of the sections, and in a smaller type, so as not to interrupt the continuity of the work, or weaken its claim to the rank of a systematic treatise.

Human Anatomy cannot be considered as an abstract science: scarcely any one enters on its study unless with a view to make practical application of the facts it discloses, in the treatment of diseases. It is on this account that the works of some of our scientific and erudite neighbours on the continent are found so defective as assistants to the inexperienced. Some even of the treatises most generally read, treat Anatomy as if it were cultivated by itself, and for itself, or in other words, as if a knowledge of the anatomical characters of bones, muscles, arteries, &c. constituted the ultimate object which we seek to attain. A student looks to them in vain for any suggestions as to the method of conducting his anatomical analyses; he searches in vain for even an occasional remark on the practical applications that may be made of the different facts brought under his notice; and were he to follow their guidance for even a year or two, sedulously devoted to the study of descriptive Anatomy, he should then commence a new course, and select some other guide to teach him the use that is to be made of the knowledge he has acquired.

As a knowledge of Anatomy throws considerable light on our curative indications, in the different forms of disease, so a knowledge *à priori* of disease is of use to the anatomist, both by indicating the objects which should be kept in view whilst examining the different regions of the body, and still more so, in giving an additional zest to his inquiries. It is on this principle that the author has subjoined to the description of the different arterial trunks the most approved method of exposing them in different parts of their course, so as to place ligatures upon them. With this view he has also given detailed descriptions of the mode of conducting the examination of those regions of the body which are occasionally the seat of capital operations. The dissection of the inguinal region naturally suggests to the mind the propriety of considering the different structures contained within its limits, in reference to the diagnosis, relations, and treatment (by operation) of the more ordinary forms of hernia; and our examination of the perinæum could scarcely be said to contribute to any useful purpose, were it not so conducted as to impress on the mind clear ideas of the manner in which a catheter should be introduced, and the operation of lithotomy performed.

A knowledge of anatomical facts and of their practical applications, though of primary importance in itself, should not form the ultimate limit of a professional man's inquiries. "Knowledge," says a great authority *, "though founded in particulars, yet can expand itself only by general views." To study the different parts of a complex machine in detail surely cannot be sufficient for those whose duty it is to restore its regular actions when deranged, and the due performance of which duty pre-supposes a correct knowledge of the general principles on which it is constructed, and the relations which its parts severally bear one to the other. In a work such as the present, written professedly on descriptive and practical anatomy, general principles could only be introduced with a view to elucidate its main design. Hence the summaries which are given of the general anatomy of the osseous system, of the articulations, of the circulation in the adult and in the fœtus, must necessarily have been very much abridged; but it is hoped they will be found sufficient to place before the reader correct *coup-d'œil* views of these important topics.

There is one consideration which cannot be too strongly impressed on the mind of every individual about to enter on the study of anatomy; it is the indispensable necessity of acquiring, at the outset, a correct and thorough knowledge of the osseous and muscular systems, as reference is constantly made to them during the description of every other part of the body. If this be neglected in the first instance, the deficiency will seldom be supplied at a subsequent period, and at every step of the student's progress he will feel the want of certain portions of knowledge, which reminds him that an important link in the chain of demonstration is lost. As well might a person hope to acquire clear notions of the demonstrations in Euclid's Elements without a knowledge of the definitions and axioms to which reference is made in every problem, whether it be simple or complex, as hope to prosecute anatomy with success without an accurate knowledge of those parts which form the basis of all the others, and to which allusion is made in every subsequent step of his progress.

---

* *Locke.*

London, Aug. 30, 1828,
MEDICAL SCHOOL, ALDERSGATE-STREET.

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ELEMENTS OF ANATOMY.

INTRODUCTION.

1. Anatomy, considered as the science of organization, includes within its limits all organized bodies, and has for its object the study of their structure and properties, physical as well as vital. A science of such vast extent must necessarily comprise too great a variety of details to be adequately investigated by any single individual; its progress and improvement up to the present time, have been owing to the exertions of different persons devoting themselves each to a particular department of the pursuit; and if we may judge of the future by the past, it is not too much to say, that its further advancement must depend on a similar co-operation, conducted on the principle of the division of labour. Thus some have applied themselves to the examination of the structure of vegetables, others to that of animals; whilst those engaged in the study of medicine have confined their attention to that of the human species, which has given occasion to the formation of three distinct departments, viz. *vegetable*, *comparative*, and *human* anatomy.

2. Comparative Anatomy has been cultivated for the most part with a view to ascertain, by an examination of the different classes and orders of animals, the characters common to all, as well as those peculiar to each, and to establish a methodical arrangement of them, founded on their natural affinities. Human anatomy is studied, not merely because it serves to explain the structure of the body, nor because it leads to a knowledge of the uses of its different

parts, but because of the light which it sheds on the seat, nature, and causes of the disease,—a light without which medicine would be little else than a blind empiricism.* Though anatomy is with perfect propriety included amongst the natural sciences, it differs altogether from zoology, both in its plan and object: the latter dwells on the external form and characters of organized bodies, the former, on the contrary, seeks to explore their interior, and resolves them into their component parts, in order to arrive at a knowledge of their structure and properties.

An opinion seems to be entertained by some persons, that the study of zoology and comparative anatomy should be considered rather as an amusement, than as a philosophical pursuit—as something calculated to employ light minds, or occupy hours of leisure and amusement. A slight examination will, however, suffice to shew that the facts it unfolds are not merely interesting; they will be found to be instructive in the highest degree, as they tend to throw considerable light on several obscure points connected with the anatomy of the human body, by affording the means of comparing the composition, arrangement, and properties of its different organs, with the corresponding parts in the lower animals. "The varieties of organization supply in the investigation of each organ and its functions, the most important aids of analogy, comparison, contrast, and various combination; the nature of the process receives, at each step, fresh elucidation, and the basis of our physiological principles is rendered broader and deeper, in proportion as our survey of living beings becomes more extensive." Moreover, the study of comparative anatomy forms a useful exercise and discipline to the mind, by requiring a close attention to facts and principles, and the adoption by a clear and methodical arrangement. "This advantage of distributing and classing a vast number of ideas, which belongs in a remarkable degree to natural history, has not yet been so much insisted on as it deserves; it exercises us in that important intellectual operation which may be called method, or orderly distribution, as the exact sciences train the mind to habits of close attention and reasoning. Natural history requires the most precise method or arrangement, as geometry demands the most rigorous reasoning. When this art (if it may be so called) is thoroughly acquired, it may be applied with great advantage to other objects. All discussions that require a classification of facts, all researches that are founded on an orderly distribution of the subject, are conducted on the same principle; and young men who have turned to this science as a matter of amusement, will be surprised to find how much a familiarity with its processes will facilitate the unravelling all complicated subjects."*

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* PORTAL, *Anatomie Médicale*, preface, p. 1.

3. A single instance will suffice to shew the application that may be made of the researches of the comparative anatomist, in elucidating the structure and functions of one of the most complex organs of the human body, viz. that of hearing. It is obvious that the general conformation of organs must have a reference to the more or less perfect development of the animals to which they belong, being more simple in those of the lower grades, and becoming more complex in proportion as they occupy a higher rank in the scale of animated beings; their structure too, must bear some relation to the medium in which the animals live, and be influenced by the circumstance of their being inhabitants of the air or of water. When treating of a particular organ, for instance the ear, it may at first sight appear calculated to embarrass the subject with useless details, were we to review its conformation in the different classes of animals; it may be said that it would be far better to confine our attention to the human ear, about which alone we can feel any interest. But it should be recollected,

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* LAWRENCE, *On the Modern History of Comparative Anatomy*, p. 29. CUVIER. *Règne Animal*, preface, p. 18.

that if a subject carry within itself any degree of complexity, there is no course more likely to lessen it, than that "of proceeding from things more simple, to those more compounded;" and if this principle be applied to the subject just alluded to, we shall find, that so far from rendering it more difficult, it will remove from it even the appearance of difficulty. When we examine an organ in its simplest form, we at once ascertain its essential or fundamental constituent; and if we trace it through the different grades of animals, from the lowest to the highest in the series, we can readily recognize each of the accessory parts which are successively superadded, and assign to them respectively the rank which they fill, and the duties they perform.

4. The simplest form of auditory apparatus is a small sac containing a fluid, and enclosing the sentient extremity of the auditory nerve. Its exterior envelope is fibrous in the lower animals, cartilaginous in others, and finally osseous in the higher orders; it presents two apertures, placed at opposite points of its circumference, of which the internal one serves to transmit the acoustic nerve, while the other maintains the relation with the external world: and as the sac is analogous to the vestibule in the higher animals, these openings may be said to correspond, the one with the meatus auditorius internus, the other with the fenestra ovalis. Within this first investment is placed a vascular membrane, which lines it throughout, and encloses and supports the nerve: this, however, does not seem to be expanded to the same extent as the nervous membrane of the eye; still, like the retina, it is in immediate contact with a fluid which bears some analogy to the vitreous humour, for each is enclosed in a membrane which enables it to retain its form, and prevents it from being diffused in the cavity in which it is lodged; and both serve as media of transmission for the appropriate agents of impression. This simple apparatus is covered over by the cranial integuments, and as they exclude all contact with the medium in which the

animal lives, the impressions of external objects must be conveyed to the sacculus, through the bones of the head generally. The first change in the structure of the part is intended for the improvement of the acoustic or sentient apparatus, and consists in the addition, as it were, to the sacculus, of three semicircular canals, which consist of a fibrous, cartilaginous, or osseous envelope (corresponding in this particular with the structure of the fundamental part, from which they are prolonged like so many diverticula), a vascular lining, an expanded nerve, and a fluid. In some cartilaginous fishes the organ consists merely of the fundamental part (the sacculus or vestibule). In the skate and shark the semicircular canals are added. In the amphibia the development improves somewhat. In the class of reptiles the two first parts of the labyrinth attain their complete form, and a rudiment of the third is added, viz. the cochlea, which consists of the same structures as the others, and like them serves to contain a prolongation of the auditory nerve. The vestibule and semicircular canals in birds, present nearly the same conformation as in the higher reptiles; the cochlea is still rudimentary; but the tympanum is large, and traversed by the ossicula; the membrana tympani may be observed at the bottom of the auditory canal, round which the external teguments are sometimes folded, so as to represent a rudiment of a concha. In the mammalia, the auditory apparatus attains its complete development, and as it comprises all those parts found in various degrees of perfection in the lower orders, it may be considered as divisible into four distinct compartments, each intended for a separate office.*

1. The essential or fundamental part (vestibule).

2. The accessory apparatus (semicircular canals and cochlea).

3. The middle chamber and its ossicula, for the transmission of sounds (tympanum).

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* De' Blainville, *Principes d'Anatomie comparée*, p. 450.

4. The external apparatus for collecting and concentrating sound (external ear).

After reviewing in this way the different parts of the organ successively, and after inspecting it as a whole, we may not inaptly compare it to an edifice consisting of several apartments, each fashioned after a particular manner, and intended for a distinct purpose. The external part may be likened to the portals of the edifice, at which the visitors are collected previously to their entry, and after they have been there assembled and arranged, they are led across the ante-chamber by certain conductors stationed there for that purpose; by these the visitors are ushered into the presence-chamber, enclosed within the winding recesses of the labyrinth, and as they are successively introduced, they register on the tablet of the memory, their degrees, their titles, and their properties.

5. The study of human anatomy has been especially pursued by the professors of the healing art, who, on just grounds, consider it as the most secure basis on which they can rest their investigations of the functions of the body in health, and of its derangements in diseases. Were anatomists to confine their attention altogether to the human body, they would doubtless acquire a sufficiently accurate knowledge of the situation, form, connexions, and even composition of its different parts; but though an acquaintance with such details forms a necessary part of the pursuit, it is far from constituting the final object to be aimed at. The natural or healthy actions of the body must be studied as a preliminary step to the knowledge of their morbid conditions; the laws which preside over the formation and development of living beings must be fully investigated before their functions can be rightly understood; and were we to restrict our views to the examination of any single species (even though it be the most perfect of all) our knowledge would be as inadequate,—our ideas of the laws of the economy would be as confined as those of

a geographer would be of the extent and resources of a kingdom, were he to limit his inquiries to a single province or department.

6. Human anatomy may be studied in two different conditions of the structures of the body, and so may be directed to two distinct objects. By the one a knowledge of the healthy condition of parts is sought to be attained; by the other, of their morbid characters, and on this distinction is founded the division of the subject into two sections or departments, viz. *healthy*, or *descriptive anatomy*, and *morbid*, or *pathological*. The changes of structure induced by disease can only be ascertained by an examination of the body after death; but though a knowledge of these changes is confessedly a matter of importance, it can only be brought into practical application when they are connected with the alteration of functions, or the symptoms which had accompanied them during life. When by repeated and accurate examinations the different structural lesions of each organ are fully investigated, and their appropriate symptoms so clearly ascertained, that they are made to bear to one another the relation of sign and thing signified, the diagnosis of diseases may be considered as established on a basis sufficiently extended to warrant us in resting upon it our curative indications.

It may be here observed that anatomy, in the original and literal acceptation of the term, merely served to denote one of the methods of examination used by those who applied to the cultivation of the science. It consisted in the dissection of parts, which required no more than a scalpel for its execution, and sufficed for all the purposes sought to be attained during the earlier periods of the history of medicine. But as the objects of pursuit became multiplied, the methods of examination were necessarily varied, and several other processes were from time to time introduced, such as injection, maceration, desiccation, chemical reagents, &c., with a view to arrive at a more intimate knowledge of the composition and structure of the different parts of the body. Notwithstanding these changes, the same term has been still retained, and is allowed by general consent to include within its comprehension not only the means employed, but also the end which is sought to be attained. The progress of these changes may be readily traced, by examining some of the anatomical works which have been published at different times; and they whose age has allowed them opportunities of comparing the style and tenor of the courses of lectures delivered by the individuals who have successively discharged the duty of teachers in the schools, are well aware that a considerable alteration has taken place in the plan and scope of their discourses, as well as in the quantity of information they convey.

7. It is a great mistake to suppose that the practice of medicine or surgery requires only a trifling knowledge of anatomy, or that a loose and general idea of it will suffice for the proper discharge of our professional duties. The history of surgery at once disproves such a notion, by shewing that the fatality attendant on operations has diminished in proportion as anatomy has been more diligently cultivated,—(the best proof of an improvement in its practice that can be adduced)—and the rapid advances that have of late years been made in establishing the pathology and diagnosis of diseases, more especially of those of the cerebro-spinal system, as well as of the lungs and heart, are altogether attributable to the degree of attention that has been paid to that most important department of study, pathological anatomy. The latter position is fully borne out by the great success that has attended the researches of Laënnec, Abercrombie, Lallemand, and many others; the former may readily be verified by a reference to the his-

tory of any of the more important surgical operations. The performance of lithotomy, for instance, once so formidable and so fatal, is now no longer so; it is executed with a degree of facility and success that could scarcely have been expected, if the many difficulties and dangers that beset it be taken into account. The tying of arteries for the cure of aneurisms, has also been materially improved; and the improvements have gone on step by step, in proportion as a more accurate knowledge has been attained of the structure and properties of vessels, and of the anatomy of those parts of the body which are the immediate seat of these operations. In the first cases treated by Mr. Hunter, four ligatures were passed round the vessel which was divided in the intervening space. Two of these were called safety ligatures, being intended to be drawn tight if the others gave way. It was soon however found that "safety" meant in reality danger, inasmuch as the ligatures, by being placed in contact with the coats of the vessel, acted on them as any foreign body must do,—they excited inflammation, ulceration, and consequent hæmorrhage, thus inducing the effect they were intended to avert. The additional ligatures were therefore soon omitted, and several other improvements have been since adopted from time to time, all tending to simplify the process of cure, but each founded on some additional information acquired concerning the properties of the vascular system. In the mechanical or dissecting part of these operations, we can also recognize a corresponding improvement, as is evident from the greater ease and celerity with which they can be now performed. The first individual in whom the subclavian artery was tied, must have been on the table some hours, and so difficult and even hopeless did the attempts appear to place the ligature round the vessel, "that some of the assistants became so strongly impressed with the idea of the patient's danger, that they quitted the room, lest he should die before their eyes."* The same vessel has since been secured in from ten to fifteen minutes, with the greatest precision and complete success.

8. But, it may be asked, is it a matter of much consequence whether an operation is performed quickly or slowly? Will a difference of a half hour, or of an hour in its duration, influence its ultimate result? Abundant evidence may be adduced to shew that it may, nay, that it has done so in several instances. When a patient has made up his mind to submit to an operation, he does so with a certain degree of consciousness of the risk which he encounters, and of the sufferings he is about to endure. If the operation be executed with great precision and celerity, the degree of suffering during its performance is far less than he had been prepared to expect, and when it is over, it may readily be perceived that confidence and self-gratulation at once take the place of doubt and despondency, and that a sense of security springs up in his mind, which exerts a most beneficial influence on the subsequent progress of the case. Another individual may happen to be placed under different hands, is harassed by a slow and protracted operation, begins to doubt the skill of his surgeon, even whilst it is being performed, and to despair of obtaining the relief which he had so anxiously anticipated: even when the operation is completed, and he is replaced in his bed, confidence still forsakes him, for he cannot bring himself to believe that any human being could recover after sufferings so protracted, and after sustaining such a degree of derangement and injury. Those who have been long acquainted with the minutiæ of hospital practice—more especially those who have watched the cases from day to day, and noted their progress, need not be informed of the different results that

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* Colles *on the tying of Arteries.* Edinburgh Medical and Surgical Journal, January, 1815.

attend the two classes of cases which are thus contrasted. The one they have seen cheerful and contented, making a gradual and steady progress to improvement, whilst the others but too often sink irrecoverably, victims to constitutional irritation,—to moral depression. They who have had opportunities of making such a comparison need not be told, that on the speedy and judicious performance of an operation depends alike the credit of the surgeon and the safety of the patient: and what motives more powerful can be adduced—what incentives more cogent can be urged to impel a man of reflecting mind to apply sedulously to that pursuit on which so much depends?

9. Whilst conducting the examination of an organ, or when giving what may be termed its anatomical history, the anatomist (says Beclard*) should consider his subject as divisible into the following heads, and should treat each of them *seriatim et singulatim*. 1st. Its form and outline—its disposition, as being symmetrical or irregular; 2nd, its situation in reference to contiguous parts, as well as regards the entire body; 3rd, the direction of its great diameter, which may be parallel, oblique, or perpendicular, to the axis of the body; 4th, its size; 5th, its physical properties, viz., its degree of density, cohesion, elasticity, colour, &c.; 6th, its anatomical composition and texture, or the arrangement of its integral parts; 7th, its chemical composition and properties; 8th, the fluids or humours which it contains, or secretes; 9th, the properties it manifests during life; 10th, its vital action, and the connexion of that action with others; 11th, the varieties dependant on age and sex, or individual peculiarities; 12th, the morbid changes.

Some of these topics may appear to belong to the departments of chemistry, physiology, or pathology, rather than to anatomy; still "none of them should be omitted, as all are necessary to guide the researches of the anatomist."* A correct and intimate knowledge of the structure and composition of each organ is indispensably necessary to the understanding of its functions; an acquaintance with the structure and functions leads, by an easy and natural transition, to the investigation of the lesions of structure and function induced by disease,—the only data on which we can establish a correct diagnosis and a rational plan of treatment. These views are briefly stated by Beclard in his work on General Anatomy; they were fully developed in his oral lectures; and, if we refer to Professor Meckel's treatise on Anatomy, we shall find every part of the subject treated on nearly the same plan, and with equally comprehensive views. A single instance will suffice to show his mode of division and arrangement.

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* *Anatomie Générale*, p. 132.

Art. 3. *The accessory organs of the abdominal portion of the alimentary canal.*

1. The liver.
   - A. Of the liver considered by itself.
     - a. Its situation.
     - b. — dimensions and weight.
     - c. — form.
     - d. — connexions.
     - e. — colour, specific gravity, and consistence.
     - f. — structure.
   - B. Of the excretory part of the biliary system.
     - a. The hepatic duct.
     - b. The cystic duct.
   - C. Differences depending on development.
   - D. Morbid changes (anormal condition).
     - a. Of the liver.
     - b. ——— biliary ducts.
     - c. ——— bile.

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[*] BECLARD, p. 132.

Few could venture upon such an undertaking as that of collecting and arranging all the established facts and principles that are connected with anatomy (special as well as general) physiology and pathology; none but a Meckel could have executed it in a style worthy of the present state of medical science. This great anatomist did not rest satisfied with consulting (whilst composing his treatise) all the standard works, ancient as well as modern, which treat expressly of anatomy and its collateral branches—he has also examined almost all the detached papers and essays which lie scattered through the pages of the various periodical publications, and journals of scientific societies, not only of his own country, but of every country in Europe; and on perusing his work it will be found to contain the most valuable part of the materials derived from these different sources, blended with some that may be considered original. Such a production as this is valuable to the present generation from the quantity of information it contains, and at any future period may be appealed to as the best criterion of the state of opinion, at the time in which it was written, concerning the most important subjects of anatomical research. But this is not all—Meckel may be considered to have laid down, by this publication, the plan and scope of the courses of instruction which should be given by teachers of anatomy, if they intend them to be at all commensurate with the present state of anatomical science. The main object of a course of lectures is to make those who attend them fully acquainted with all the established facts, as well as admitted principles of the subject of which they treat: so that they may be considered "as placed on a level with the present state of science." If this be accomplished, it is not difficult, with a moderate degree of assiduity, both to retain what has been already acquired, and keep pace with the progress of such improvements as may, from time to time, be introduced.

10. Systematic treatises have been very generally found

unsuited to the purposes of those who are commencing the study of anatomy. The descriptions which they give of different parts of the body are, doubtless, sufficiently full and clear, yet, as each system of organs is considered separately, and, as it were, apart from the others, the student finds himself constrained whilst prosecuting his pursuits from day to day, to consult different parts of the same volume, and, not unfrequently, different volumes of the same work. Anatomy, or rather the process of dissection, resembles that of analysis, as its object is to resolve a part, or the whole of an organized structure into its proximate constituents, in order to ascertain their outward conformation, volume, relative proportions, and physical properties. Though the books just referred to furnish all the necessary information on these subjects, they have been found insufficient as guides to the inexperienced, inasmuch as they convey no information as to the mode of conducting the analysis. To remedy this defect some works have been published on a plan altogether different from that of the systematic treatises. In these, instead of treating *seriatim et singulatim* of the different systems of organs of which the body is composed, it has been considered as divisible into regions, each requiring anatomical investigation; and as into each of these enters some part of all the organic systems—as it is supported by the osseous, moved by the muscular, nourished by the vascular, and derives sensibility from the nervous; these are examined, not separately and in detail, but collectively, as they are grouped together by nature in the regions which they occupy. These views were suggested by the study of anatomy in relation to operative surgery, and have constituted the basis on which the works of Burns, Colles, Harrison, Velpeau, and Blendin, have been constructed; which are obviously intended for persons somewhat advanced in their studies, as their readers are pre-supposed to be acquainted with at least the outlines of anatomy.

There is also another class of books in very general use, denominated Manuals of Anatomy, written by Messrs. Scratchley, Green, Bell, Shaw, and Stanley. These have been formed for the most part on the plan adopted by the writers on surgical anatomy, and have been found productive of considerable advantage to students during the earlier periods of their pursuits. Notwithstanding the existence of so many works in this department of medical literature, it is now very generally admitted that there is still room for another. The present work comprises the substance of the courses of Anatomical Demonstrations, delivered by the Author at the Medical School, Aldersgate-street, and has been arranged according to the same plan, at least there has been no other deviation, except what was required by the obvious difference between a course of oral lectures, and a written book. Instead of examining each system of organs separately, instead of passing in review the whole skeleton in the first place, then proceeding to the muscles, and afterwards going the round of the vascular and nervous systems, the author has adopted the practice of commencing with a particular part, usually the lower extremity, and of examining its composition in the following way:

11. The osseous structure, considered as the fundamental part of the limb, is described first, inasmuch as it gives form and solidity to the whole, and constitutes the substratum, to which the others are, as it were, applied. As the osseous part is divided into several pieces, differing from one another in form and size, and as these are united together by certain means of connexion so constructed, as to admit of various degrees of motion between the parts, the consideration of the joints or articulations, and of the textures which enter into their formations, in the next place engages attention. The bones, with their ligamentous connexions, constitute together the passive instruments of locomotion, the active agents in progression, as well as in the

different efforts required to be performed, being the muscles, which, as their name implies, are the moving powers of the body. Each of these exerts a peculiar action, which in most instances is perceptible on the slightest inspection; but if any doubt arises, it can at once be removed by a consideration of the direction of its fibres, and of the bearing of the points between which they are stretched. Muscles, however, seldom act singly; two or more usually combine in the performance of each effort, by which some advantages are gained, at the same time that the symmetry of the different parts of the body is preserved. These considerations have suggested to anatomists the idea of dividing the muscles into groups, the division being established by a reference to the manner in which they are associated in their combined actions. Winslow, when reviewing the actions of the muscles of the upper extremity, arranges them under the following heads:—

1. The actions of the muscles which move the bones of the shoulder on the trunk.
2. The actions of the muscles which move the os humeri on the scapula.
3. The actions of those which move the bones of the fore-arm on the humerus.
4. The actions of the muscles which move the radius on the ulna.
5. The actions of the muscles which move the carpus on the fore-arm.
6. The actions of those which move the fingers.

Bichat fully coincides with Winslow as to the propriety of studying the combined actions of muscles, but he has adopted a different division and arrangement, which the author has deemed it advisable to follow, as being more simple and easy of comprehension. To the practice of surgery, an accurate knowledge of the actions of muscles is indispensably necessary. It forms the basis of all our remedial means in the reduction of dislocations—in the treatment of fractures, it determines the proper position of parts under various circumstances of accident or injury; and though within the wide range of the anatomist's study, many subjects present themselves well calculated to awake attention—to excite an interest, there are none more likely to do so than the varied phenomena of muscular action.

12. Muscles, like all other agents, however they may be constituted, require support; they must be supplied from some source with the materials of nutrition and growth as well as of reparation, should they become the subjects of accidental injury. These various purposes are fulfilled by the arteries, which convey the necessary supplies; these in the next place claim attention, and require a particular examination, in order to determine with precision their course, direction, and mode of distribution. As the blood conveyed by these tubes is not altogether expended in the functions they are intended to perform, the residue, altered considerably in its properties, passes into a new set of vessels,—the veins, by which it is conveyed back to the heart preparatory to its circulation in the lungs, in which it is aërated. Now the remote or peripheral extremities of the veins are continuous with the capillary terminations of the arteries, the trunk being implanted into the heart; and, as they serve to complete the circle, their distribution is examined after that of the arteries, taking it however in the opposite direction, viz. from the branches to the trunks.

13. However intimate the connexion between these different structures may be, they are linked together even still more closely by another, which may be considered as superinduced upon them, for the purpose of associating into one harmonized mass all the parts of the body, and of establishing between them a reciprocal dependance and relation. These duties are in a manner delegated to the nervous system, whose fibrillæ are ramified through all the

other textures, whilst these central terminations are blended with the cerebro-spinal mass. The examination of the nerves follows naturally that of the parts to which they communicate the powers of sensation and motion, and of whose nutritive functions they may be said to be the regulators; and this would complete the consideration of the deep-seated parts, if the materials of which the body is composed were allowed to remain fixed and unchanged in the situations from which they are at first deposited. But this is not the case. The component particles of all the structures undergo a slow, but constant change; after a temporary sojourn some parts are taken up and carried back again into the circulating mass, to make way for others to be deposited in their place. A peculiar set of vessels, the absorbents, effect these purposes, and are thus made subsidiary to the process of nutrition and growth. Finally, the integuments which enclose these different parts demand a greater or less degree of attention under different circumstances.

When the anatomical description of a particular part of the body is thus completed, when the structures which enter into its composition are successively examined in detail, maintaining at the same time a strict regard to their mutual relations and bearings—when, in a word, the student has seen the part built up as it were before him, by a process resembling, as nearly as may be, a synthesis, he is naturally prompted to inquire what are the steps by which it may again be resolved into its elements, in order that he may study it for himself, or in other words, how should he conduct its analysis or dissection? No part of the process should be treated as a matter of indifference. Every one may be turned to account if it be conducted with method. Even the first incision made through the skin may be so directed as to impress on the mind some useful practical facts. Recurring again to the instance already selected, viz. the lower extremity, and which has been kept constantly in view, whilst making the preceding remarks, and bearing in mind the leading facts, which its examination has disclosed, we recollect the course taken by its main artery, the femoral. If the knee be somewhat bent, and the limb turned outwards, the direction of that vessel is at once marked out by a line extended from midway between the anterior superior spinous process of the ileum and the symphisis pubis, to the lower margin of the patella: this position applies so far as the vessel retains the name femoral, which is only for two-thirds of the length of the thigh; for at the junction of the middle with the lower third the vessel changes its name, at the same time that it alters its relation to the bone, and is denominated popliteal. In the upper third of this course the vessel is uncovered by muscle, and is therefore the part most eligible for its compression, or the application of ligatures, whilst in the middle third it is deeply seated, and less favourably circumstanced. Now all these facts, with which every surgeon should be accurately acquainted, may be expressed, if such a phrase be allowable, by the incisions which the dissector is instructed to make, with these additional advantages, that they are the most convenient that can be adopted for prosecuting the different steps of his examination, at the same time that they serve to leave a lasting impression on the mind; for, to use the words of Locke, "constantly repeated ideas cannot be lost." If this routine were adhered to strictly in the composition of an anatomical work, it would have embarrassed its arrangements with rather a complex division of the subject; on this account it has been deemed advisable to complete the description of the bones and their articulations, previously to entering on the consideration of the other structures.

14. In concluding these introductory remarks, it may not be amiss to point out the best sources from which information may be obtained on the subject of Anatomy, general as well as descriptive, a duty the more willingly undertaken, as it affords the author an opportunity of acknowledging

his debt of obligation to those whose works he has been in the habit of consulting, during an unusually protracted period of study, both in this country and in other countries. The department of general anatomy comprises only the work of Professor Meckel, already alluded to, and those of Bichât and Beclard. Their titles are as follow:—

MECKEL, *Handbuoh der menschlinchen Anatomie*, Halle. The French edition of the same, translated, with notes by BRESCHET and JOURDAN, entitled *Manuel d'Anatomie Gènèrale, Descriptive, et Pathologique*, par J. F. MECKEL, Paris, 1825.

BICHAT, *Anatomie Gènèrale, avec des additions* par BECLARD, Paris, 1821.

BECLARD, *Elemens d'Anatomie Gènèrale*, Paris, 1823.

The treatises of descriptive anatomy are:—

WINSLOW'S *Anatomical Exposition of the Structures of the Human Body*, 2 vols. 8vo. translated by G. DOUGLAS, M.D. Edinburgh, 1763.

SOEMMERRING, *De Corporis Humani Fabricâ*, 5 vols.

PORTAL, *Cours d'Anatomie Medicale*, 5 tom. Paris, 1823.

BELL, (JOHN and CHARLES) *Anatomy and Physiology of the Human Body*, 3 vols. London, 1826.

BELL, (CHARLES) *Exposition of the Nervous System.*

MONRO, *System of Anatomy*, 3 vols. Edinburgh, 1792.

FYFE'S *Compendium of Anatomy*, Edinburgh, 1826.

HALLER, *Opera Omnia.*

BOYER, *Traitè Complet d'Anatomie*, 4 tom. Paris, 1815.

BICHAT, *Traitè d'Anatomie Descriptive*, 5 tom. Paris, 1802.

CLOQUET, (HIPPOLITE) *Traitè d'Anatomie Descriptive*, 2 tom. Paris, 1812.

CLOQUET, (JULES) *Anatomie de l'Homme*, fol. avec figures lithographiées, Paris, 1824.

ELEMENTS OF ANATOMY.

CHAPTER I.

15. The human body, considered as the subject of anatomical investigation, may be viewed as a whole, made up of several parts, each ministering to distinct purposes, and all more or less necessary to the life and well being of the individual. As effects cannot follow without causes, or actions be performed without instruments, so, in a fabric at once so complex and delicate as that of man, many agents or organs must be employed to execute the various functions which are required for the support of the individual, and the continuance of the species; these the anatomist studies, either singly or arranged in groups, according to their functions; or he resolves them into their elements, to ascertain their composition and structure. Even on a superficial inspection, an obvious division of the body at once presents itself, viz. into head, trunk, and extremities. The trunk, composed of two compartments, or cavities, encloses several of the more important organs; the inferior and larger cavity, the abdomen, contains the organs of digestion, those engaged in the secretion and excretion of urine, and part of the generative system; whilst in the thorax, or superior one, are placed those of respiration and circulation. The head gives lodgement to the organs of sense, at the same time that its cavity, by means of its communication with the vertebral canal, encloses the central organs of innervation, viz. the brain and the medulla spina-

lis. The trunk and head, in their composition, are symmetrical, being made up of two lateral halves, united along the middle line by a suture, or raphé, the traces of which are more or less perceptible in different parts; and this symmetry is closely maintained in the extremities, or agents of locomotion, which are connected, the one with the upper, the other with the lower part of the body. The external line of junction corresponds with others observable in the interior, and which are the necessary results of the mode in which the body and its different organs are in the first place developed. Thus the falx cerebri descends from the middle of the arch of the skull, taking the direction of an osseous ridge running along the frontal and occipital bones. Beneath this is the corpus callosum, forming a connecting medium between the cerebral hemispheres, and from which projects the septum lucidum, which bears to the internal cavities of the brain, the same relation that the falx does to that of the cranium. The division of the nasal cavity is marked out by the septum narium; that of the mouth by the fræna of the tongue and lips, as well as by the uvula. The division in the thorax is indicated by the mediastinum; in the heart, by the septum interposed between its cavities; in the abdomen the only traces that exist in the adult of its original division, are the falciform processes, extending from the umbilicus, the one upwards, with the remains of the umbilical vein, the other downwards, with that of the urachus; but in the penis and clitoris, the line is distinctly marked by the septum of the corpora cavernosa, and in the scrotum and perineum, by the raphé.

16. It has been hitherto supposed, that in the original development and growth of organized bodies, the increase proceeded from the centre towards the circumference. Recent researches* have, however, demonstrated the reverse to be the fact, and have shewn, that each organ is in the first instance double, its parts being placed laterally

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* Serres, *Anatomie Comparée du Cerveau.*

with regard to one another, but that, as the process of nutrition goes on, they gradually approach and unite, so as to form organs usually termed single, from the circumstance of their having been examined only after their growth has been completed. The process of ossification for instance, proceeds from the circumference towards the centre. Thus the lateral parts of the cranial bones are formed first. The alæ of the sphenoïd are formed before its body; so are the lateral masses of the ethmoid, whilst the central part remains imperfect, until the deposition of ossific matter extends inwards to the middle line. Each vertebra of the spinal column, and therefore the whole pillar itself, even including the sacrum, is composed of two parts, which finally become soldered together at the part denominated the body. This principle obtains in all cases, even where the structure consists of a simple tube. The course of the intestinal canal is at first marked out by two flat bands running along its entire length; these unite in front, so as to form a groove, the margins of which finally arch in and complete the tube. In this way the aorta, trachea, larynx, and œsophagus, are formed. This principle of eccentric development obtains in the muscular system also, the lateral parts being produced before those at the middle line. On the head the temporal, masseter, and pterygoïd muscles, are the first that can be recognized; the zigomatici, the buccinator, and orbiculares, come next in order; and lastly, those of the nose. On the thorax, the intercostals precede the muscles situated in the costospinal fossæ, as well as those attached to the sternum; and in the abdominal region, the obliqui are formed in the first instance, the recti and pyramidales, situated along the middle line, subsequently. The abdomen in fact, in the early periods of fœtal life, presents an open cavity, the viscera being quite uncovered, but in proportion as the muscles extend inwards from the circumference to the centre, the opening becomes gradually diminished, and the organs enclosed, so that at birth no interval remains, except that which transmits the umbilical vessels.

17. The nervous system, in its development, obeys the same law; the nerves on the sides of the head, trunk, and pelvis, are formed independently of the brain and spinal marrow, and their cords and filaments may be distinctly traced, before even a rudiment of the cerebro-spinal masses is perceptible,* so that the nerves may be said to begin where they have been hitherto thought to terminate, and *vice versâ*. The medulla spinalis, when just distinguishable, consists of two lamellæ, or bands, separated by a slight interval; these soon unite in front, so as to form a groove, and finally at the opposite point, constituting a cylindrical tube, which is gradually filled up by a series of lamellæ deposited one within the other, until it is converted into a solid mass of a cylindrical form. The lateral masses of the brain when first deposited, are quite distinct from one another, but as the process of growth extends towards the central line, the corpus callosum, and the other commissures, are produced, which establish a medium of connexion between them, and when the union is completed, its line of direction is indicated by the raphé, perceptible along the upper surface of the corpus callosum, and which is found to extend quite through its substance. These facts claim, in an especial manner, the anatomist's attention; they point out the marked line of distinction which exists between organized and unorganized bodies. The latter are universally admitted to be produced in the first instance by an aggregation of particles of matter, regulated by the laws of chemical attraction, and subsequently increased by a deposition of similar particles round the central nucleus; the development of the latter proceeds in a course precisely the reverse of this; beginning at the circumference, it gradually extends to the centre, and so must evidently be regulated by laws differing altogether (may we not say essen-

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* SERRES, *Anatomie Comparée du Cerveau*.

tially differing?) from those which direct the formation of masses of inert matter. A knowledge of these laws has thrown considerable light on one of the most obscure subjects connected with the animal economy, viz. the occasional formation of those *bizarre* productions called monsters. They have been regarded hitherto as lusus naturæ, as if they had been formed by a total subversion of nature's laws, and admitted of no explanation on rational principles. But their existence is now ascertained* to be determined by a partial suspension or derangement of the process of development, by which certain parts are left more or less incomplete, and stinted of their natural proportions. This of course occurs most usually along the middle line, and in one case will amount to no more than a hare-lip, or a fissured palate, which are owing to a want of union between their lateral parts. The various forms of hermaphrodism are attributable to a want of union in the pubic and perineal regions, and to a derangement in the development of the generative system; and if the walls of the abdomen be incomplete, from the same cause, the viscera may remain more or less uncovered. In acephalous cases, from the like cause, the medulla spinalis and brain may be totally wanting, or whilst the former attains its natural proportions, the latter may remain incomplete to a greater or less extent. Whatever be the degree of deficiency in the cerebro-spinal organs, it is in all cases accompanied by a corresponding defect in the osseous cavity in which it is lodged. In some cases the cranial bones remain as mere rudiments, and the vertebral canal is open in its entire extent, in others the latter is closed, the imperfection being confined to the cranium and brain. It may be here observed, that the human fœtus, during the progress of its development, runs through a series of phases or changes, each of which is found to correspond with permanent conditions of organization in the animal series. At first the embryo is a mere bud, or germ, placed on a small vesicle, resembling one of the simplest worms; it soon becomes a small vermiform body, without head or limbs, which is the character of the annelides; in the next step of the change, two sets of limbs of the same length are produced, which with a caudal prolongation, constitute a resemblance to quadrupeds. If the development of the osseous system be examined, it will be found at first mucilaginous, then cartilaginous, and finally, that it passes into the state of true bone—conditions of the system analogous to that of the lamprey, the cartilaginous fishes, and oviparous animals. Again, at the earliest period of fœtal life in the human subject, the nervous system is limited to the nervous cords and their ganglia, as may be observed in such of the non-vertebrated animals as have nerves; at the next step of its progress, the medulla spinalis, and oblongata, together with the tubercula, are distinctly marked, though the brain and cerebellum are still rudimentary; so it is in the fishes and reptiles. The cerebral organs soon begin to predominate over the tubercula, and as their development proceeds, they resemble successively the corresponding parts in birds and mammalia, until finally the lobes of the cerebrum and cerebellum attain that degree of conformation which is characteristic of man. The principle here pointed out, has been deduced from an examination of the different systems of organs in the human fœtus, at different periods of their development;* and as the general results of what is now known on the subject, it may be set down, that at the earlier periods of fœtal life, the human embryo resembles animals of the lowest grade in the scale of existence, and that as its growth proceeds, it approaches more and more nearly, by successive steps, the conformation of those of a higher and more perfect organization. This principle is so fully established, that it may be considered as an axiom in physiology; yet in making application of it, we should carefully guard against falling into the error of confounding *analogy* with *identity*. It would be a great mistake to suppose that, because an analogy exists at a particular time between certain organs, or systems of organs, in the human embryo, and the corresponding parts in some lower animal, therefore there is an identity between the whole organization of the one and that of the other. The proposition is true only with regard to particular parts, which by going through a succession of changes, resemble at one time the conformation of these parts in fishes, at another in reptiles, or birds, whilst the remainder of its structure conforms to a totally different model.

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* Geoffroy St. Hilaire, *Philosophie Anatomique*, tom. ii. *passim*.

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* Meckel, tom. i. p. 50.

18. The human body is made up of fluids and solids, each resolvable into a number of proximate constituents, and these again into ultimate elements. The solids disposed in areolæ and meshes, or formed into tubes, are permeated throughout their entire extent by the fluids, and so they bear to one another the relation of containing and contained parts. The fluids, or humours, may be divided into three sorts,—

1. The blood, or central mass, which constantly flows, as it were, in a circle, alternately received into the heart, and propelled from it into all parts of the body.

2. The secreted fluids, which are separated from the blood by the different secerning organs, and are intended either for special purposes in the economy, or to be eliminated from it, viz. saliva, mucus, bile, urine, &c. &c.

3. The fluids brought into the central mass from without, being the product of absorption, and intended to supply the losses sustained by the processes of nutrition and secretion, viz. chyle, lymph.

So long as life lasts, these fluids are subjected to a constant internal motion, in which we can trace evidences of an uninterrupted separation of old particles, and a correspondent admission of new ones. The form of the body remains the same, though its component parts are subject to perpetual mutation; and over this ceaseless cycle of change presides that power which altogether suspends the ordinary play of affinities in the first moments of fœtal existence, modifies and controls them, during the succeeding stages of life, and allows them to come into action only when it is withdrawn at death.

19. As these changes necessarily imply that the fluid parts are constantly being converted into solid structures, to maintain their growth and nutrition; and again, that the particles which had for some time formed part of the solids, are taken up by the absorbent vessels, and carried back into the current of the circulation, to make way for the new matter about to be deposited in their stead, it follows that the ultimate constituents of the solids and fluids are identical, else this ceaseless conversion of the one into the other, could not take place; the only difference between them being in their mode of composition or aggregation. Thus the following simple substances are found to exist (not separately, but variously combined), in animal compounds, viz. azote, carbon, hydrogen, and oxygen, which are the chief ingredients. To these are added some others, but in small proportions, such as phosphorus, sulphur, iron, soda, potass, and lime. Some salts, as the phosphate of lime, are found in considerable quantity, whilst others, such as the muriates of soda and potass, are sparingly diffused through a few only of the animal fluids. The soft parts are made up of azote, carbon, hydrogen, and oxygen, the hard parts of the lime and phosphorus. The proximate animal compounds formed from these, are not very numerous; the following enumeration includes all that are sufficiently well characterized, and are of general occurrence, gelatine, albumen, fibrine, mucus, pichromel, urea, osmazome, resin, sugar, oils, acids. The identity of the ultimate constituents of these substances will at once appear from the following tabular view, which it is unnecessary to extend beyond the three first.

	Carbon.	Hydrogen.	Oxygen.	Azote.
Gelatine consists of .	47·88	27·20	27·20	17·00
Albumen	52·883	7·540	23·872	15·705
Fibrine	53·360	7·021	19·685	19·934

Gelatine, or animal jelly, is an abundant ingredient, not only in the fluids, but also in the solid parts of the body, as is evident from the fact, that by boiling, it can be extracted from skin, membrane, ligament, cartilage, and bone. The solution on cooling forms a tremulous mass, and if the aqueous part be dissipated by heat, the remainder becomes brittle, and breaks with a vitreous fracture; this is named animal glue. Gelatine is soluble in pure liquid alkalies, and is not precipitated from them by acids; this latter property distinguishes it from albumen, fibrine, and other animal products, and points out the method of separating it from them; its most active precipitant is tannin, with which it forms an insoluble compound.

Albumen, next to gelatine, is the most abundant constituent of animal substances. It is found in the blood, in several secreted fluids, such as chyle, synovia, &c. and forms a principal basis of some solids,of cellular membrane, skin, and glands. Its appearance is that of a viscid transparent fluid, without taste or smell, which may be coagulated by the action of heat and of alcohol.

Fibrine forms the basis of the muscular structure, and by ablution with water may be obtained free from all the more soluble parts, except some albumen, which adheres to it. It is insoluble in water or acids; but is completely dissolved by the caustic fixed alkalies. Fibrine, when pure, is destitute of taste or smell, of a pale colour, elastic, and divisible into filaments. It is obtained in considerable quantity from the crassamentum of blood, and may be recognised also in chyle.

Mucus is the viscid fluid which lubricates the mouth, nares, œsophagus, alimentary canal, and all the tubes and ducts which convey excrementitious fluids, or which open into the primæ viæ. Besides forming an ingredient in several healthy secretions, such as saliva and synovia, it exists in some fluids, particularly in that effused in dropsies, as has been shewn by Dr. Marcet. According to Mr. Brande, who has endeavoured to decompose it by means of electricity, mucus consists of albumen and muriate of soda, or of albumen with pure soda. The residuum, after evaporation, is transparent, and found to be soluble in acids, but insoluble in water. For the description and distinguishing characters of the remaining animal compounds, such as urea, osmazome, pichromel, acids, and adipose matter, the reader is referred to some of the elementary works on chemistry or physiology, as they more properly belong to these departments. The quantity of the fluids exceeds considerably that of the solid parts of the body; but it is difficult to ascertain exactly their relative proportion, as it varies according to age, sex, and constitution. Chaussier obtained what may be considered as a fair approximation, by subjecting a body, previously weighed, to destructive distillation, the result of which was, that the fluids were found to be to the solids as 9 to 1.

20. The proximate constituents of the solid parts of the body, as obtained by what may be termed anatomical analysis, have been variously arranged by different anatomists. Haller contended for the existence of three elementary tissues, each composed of fibres, distinguishable from those of the others, by certain essential and characteristic properties, viz. cellular tissue, muscular fibre, and nervous substance. These cannot be considered as elements in the strict acceptation of the term; for, when examined by the aid of a microscope, they are found to consist of two constituents—an animal matter, which is areolar and porous, and minute globules. The first, according to its mode of aggregation, forms fibres or lamellæ, which are so disposed as to constitute cells, or areolæ. This element,

modified in various ways, may be said to form the greater number of the structures of the body; and when within its texture are deposited the globules, muscular fibre, and nervous fibre, are the results; but the circumstances which determine the production of the one or the other cannot as yet be assigned.*

Adopting this three-fold division of the anatomical elements, we may with Beclard† and De Blainville‡ arrange the different textures of the body in the following order.

1. The *cellular tissue*, which is the element by far the most generally diffused, and which enters more or less into the composition of all the organs of the body. It has been variously denominated, *cellular, areolar, lanar, mucous*, &c. It is made up of pale, elastic, and extremely fine filaments, interwoven in different ways, so as to form areolæ, or spaces of variable size and figure, and calculated to contain such fluids as may be deposited with them. It possesses what may be termed the hygrometric property, by which it is enabled to absorb a portion of any fluids into which it may happen to be immersed, an effect which probably is produced by imbibition, or capillary attraction.

    a. When condensed or compressed, the cellular tissue forms the cutis, or true skin, which invests the exterior of the body, and is endowed with the power of secreting and depositing upon its surface a concrete lamella, (epidermis) which serves to moderate the effect of external impressions.

    b. The tegumentary membrane is not confined to the external parts of the body; it is prolonged into their interior, where it serves a corresponding purpose. From the lips and nares, it extends along the whole length of the alimentary canal, as well as into the different follicles and excretory ducts which open into it. The larynx, trachea, bronchi, and air-cells of the lungs, are lined in the same way by a mucous membrane; and as the whole forms a continuous surface, it has been named by Bichat,* the "*gastro-pulmonary mucous membrane.*" A similar mucous surface may be traced from the orifice of the meatus urinarius, along the urethra, bladder, and ureters, to their termination in the calyces of the kidney; also into the vasa deferentia, and tubular structure of the testes in males, and in the female, along the vagina, uterus, and fallopian tubes, on which account the whole has been denominated the "*genito-urinary mucous membrane.*"†

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* Edwards, *Mémoire sur la structure élémentaire des principaux tissus organiques de l'homme.* Paris, 1823.

† *Anatomie Générale*, p. 99.

‡ *Principes d'Anatomie Comparée*, p. 8.

c. When disposed in the form of dense compact fibres of various lengths, the cellular tissue constitutes the basis of the various fasciæ, aponeuroses, fibrous bands, ligaments, and tendons, observable throughout the body.

d. When, though condensed into the lamellar form, the cellular tissue remains permeable to certain thin fluids exhaled on the surface, it constitutes the *serous* and *synovial membranes.* These serve to give a partial investment to parts, and to line the inner surface of the cavities in which they are lodged; but they are altogether withdrawn from the contact of extraneous bodies, as well as from atmospheric influence. Their leading anatomical character is, that they form shut sacs, admitting neither an interruption to their continuity, nor perforation of their surface, and are always moistened either by a fine halitus, or vapour, which when condensed, resembles the serum of the blood, or by a thin fluid (synovia) intended to lubricate articulating surfaces.

e. The cellular tissue in certain fixed and determinate situations (always corresponding with the parts of the skeleton) receives into its meshes a deposit of osseous matter, and so forms the basis of the *osseous system*, which gives support to all the other parts of the body.

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* *Traité des Membranes.*

† Ibid.

f. By another mode of aggregation the cellular tissue is formed into fibres, which by being coiled into tubes, constitute the different sorts of vessels named *arteries*, *veins*, and *absorbents*. It should, however, be observed, that this position rests solely on the fact, that fibrine, the essential constituent of muscle, cannot be proved by chemical analysis to exist in the tunics of any of the vessels. Some anatomists contend that arteries are irritable, contractile, and muscular, others that they are merely elastic, their middle coat being composed of a peculiar texture (*tissue jaune*, *tissue elastique*) resolvable ultimately into cellular tissue. This question shall be considered fully when we treat of the general anatomy of arteries.

2. The *muscular fibre*, the second general constituent of organized structures, is characterized by irritability and contractility, which may be considered as its distinguishing properties. In warm-blooded animals its colour is red; in others it is pale, or white; but in all its forms, it is usually denominated the flesh. The fibres are always found collected into fasciculi, and these again into bundles (*muscles*), the bond of union being cellular tissue, which is interposed between them. These are the active agents in locomotion, and in all the various actions which animals perform. The muscular fibre presents some modifications which deserve notice, referrible not only to its situation and mode of arrangement, but also to the nature of the stimulant it is intended to obey.

a. When subjected altogether to the control of the will, and placed beneath the external tegument, it constitutes what Bichât termed the *muscular system of animal life*.

b. When arranged in the tubular form, and disposed around the internal tegument, or mucous membrane, it constitutes the *muscular system of organic life*, which is removed from the direct influence of the will, its appropriate stimulus being such extraneous substances as are introduced for the purpose of nutrition. In the alimentary canal we find this mode of arrangement of the muscular fibre exemplified.

c. The two preceding forms being placed, one beneath the external, the other the internal tegument, there is a third situated between these, and distinguished from them by being stimulated to action only by a fluid (the blood) which is endowed with properties so nearly analogous to those of the living solids, that Mr. Hunter, and some other physiologists, have asserted its vitality. The heart alone furnishes an example.

3. The *nervous fibre*, or the third constituent, maintains an intimate relation with the others, and produces, or at all events conveys to the muscles, their immediate excitant, which has been termed nervous fluid, nervous influence, &c. In one mode of arrangement, it forms chords (nerves) ramified through the texture of organs; in another it is disposed in masses, (cerebrum, cerebellum, and medulla) with which the nerves are connected; so that the latter serve the purpose of *chordæ internunciæ*, between the different organs of the body and the common centre of nervous influence.

21. The anatomical constituents, or elements, here enumerated, variously modified and combined, are found to enter into the composition of certain parts, each of which is marked by a particular conformation, and intended for a special purpose; these are termed organs. The word organ (*organon, instrumentum*) is used by anatomists to express the material instrument by which an action is executed, or

a function performed, for instance, the organ of voice, the organ of respiration. An assemblage of several organs contributing to a common function, is termed *apparatus*, viz. the lachrymal apparatus, the digestive, &c. and the result which follows a certain action, or is produced by an organ, or apparatus, is termed *function*.

Descriptive anatomy includes several compartments, which are variously denominated, according to the subjects of which they treat; these are usually arranged in the following order:—

Osteology (*οστεον, a bone; λογὸς, discourse, or description*) comprises the description of the structure, form, and uses of the osseous system, and its different parts.

Syndesmology (*συνδεσμος, a ligament; λογος, a description*), or the description of the ligaments and other structures, which serve as the means of connexion between bones, and constitute their articulations, or joints.

Myology (*μυων, a muscle; λογος, a description*), the description of the muscles, the active agents in the different motions and actions of the body.

Angeiology (*Ἀγγειον, a vessel; λογος*), the description of the vessels which convey the circulating fluids.

Splanchnology (*σπλαγχνον, a viscus; λογος*), the description of the viscera situated in the large cavities, and which minister to the more important functions.

Adenology (*ἀδην, a gland; λογος*), the description of the glands and absorbent vessels.

Neurology (*νευρον, a nerve; λογος*), includes the description of the nerves, brain, and organs of sense.

We shall commence with the osseous system; premising the descriptive part with the general anatomy of bone.

CHAPTER II.

SECTION I.

THE OSSEOUS SYSTEM.

22. THE osseous system is peculiarly fitted, by its solidity and hardness, not only to give support to the soft parts, and determine their form, but also to furnish points of attachment to the muscles, by which the different movements are executed. This solid frame-work of the body is made up of a number of separate pieces, the aggregate of which has been termed "*the skeleton*." The vertebral column may be considered as the central or fundamental part of the whole, both because it exists in all animals which possess a skeleton, and also because the different parts of the osseous system are either immediately or mediately connected with it as a common centre. Thus, on its superior extremity or apex, it supports the skull; laterally it gives attachment to the ribs which arch forwards, to form, with the sternum, a bony case for the lodgement of the organs of respiration and circulation, at the same time that they furnish externally a point of support for the bones of the superior extremity: inferiorly the column is immoveably connected with the pelvic bones, which are articulated with those of the lower extremity.

The osseous structure is situated deeply, being covered by the soft parts and common integuments; at least, this is the case in all the vertebrated animals, but whether the hard osseous investment of insects and crustaceous animals be strictly analogous to the internal bony skeleton of the higher classes is a point as yet undetermined by naturalists.

The enumeration given in the annexed tabular view, will be found to agree with that adopted by the best authorities.

The number of bones is differently stated by writers, the difference arising from the period of life at which the enumeration is made: in early age the number is greatest, and subsequently diminishes, when by the process of ossification two or more previously distinct pieces become united into one. The form and size of bones present a considerable degree of variety. They are usually divided into *long*, *short*, *flat*, and *mixed*.

23. The long or cylindrical bones belong in general to the parts intended for locomotion, and represent so many levers, to be moved by the muscles in various directions. When examined from the superior part to the inferior, viz. from the humerus or femur, to the phalanges of the fingers or toes, they are found to increase successively in number as they diminish in size—a disposition which gives to the superior division of each limb the great extent of motion it enjoys, whilst it allows to the inferior and terminal ones, a variety of rapid movements within restricted limits.

Each long bone presents a body or middle, and two extremities. The shaft or body is round and cylindrical in some, prismatic in others, but somewhat bent or twisted on its axis, so that the direction of its superior extremity does not correspond with that of the inferior. Whatever difference of outward form may obtain, there is little or none in that of the internal canal; it is circular in the tibia as well as in the femur. This canal is not intended merely to lodge and protect the medulla; it contributes very much to increase the strength of the bone, as has been satisfactorily shewn by direct experiment. If two cylinders contain the same quantity of matter, one being solid, the other hollow, the power of resistance of the latter is greater than that of the former, owing to its greater diameter. By this conformation also bones, without being increased in weight, afford a more expanded surface for the attachment of muscles, and acquire an adequate degree of lightness, together with sufficient superficial extent, which are important requisites in what may be considered as the passive organs of locomotion.

24. The short bones are usually situated in parts in which solidity and firmness are required to be combined with freedom of motion; for instance, in the carpus, tarsus, and vertebral column. Their external conformation is necessarily influenced and determined by that of the parts into whose composition they enter, and as they are intended to co-operate in certain common functions, they present a number of articulating surfaces, prominences, and depressions, suited to their mode of adaptation and mutual connexion.

25. The flat or broad bones for the most part serve to form the walls of cavities, or to enclose spaces. They present two surfaces, one convex, and the other concave, which conformation, by giving them an arched form, increases their power of resistance, and affords additional security to the organs they enclose. The bones of the skull and pelvis come under this denomination.

Some are so irregular in their form as not to be referrible to either of these heads. These are situated along the median line, as the occipital, the sphenoid, and ethmoid bones, and the vertebræ.

26. In addition to these divisions into classes, adopted by all writers, those who treat expressly of descriptive anatomy are obliged to have recourse to others. Thus, in order to facilitate the description of irregular bones, such as the ethmoid, sphenoid, or vertebræ, they are considered as being divisible into a central part or body, and processes; the anatomical situation of the parts forming the ground of division. In other instances it is supplied by the mode of development, as of the os innominatum into ilium, ischium, and os pubis. Finally, in some, the division is founded on the situation and uses of parts, as when the frontal bone is resolved into a frontal, nasal, and orbital portions.

27. The surfaces of bones are marked by eminences and depressions adapted to various purposes. The eminences may be ranged under four heads. 1st. Those of articulation. 2nd. Insertion. 3rd. Impression. 4th. Reflexion. Those for articulation vary according as they are moveable or immoveable, and shall be described in the next chapter. Those for insertion are variously adapted for the attachment of muscles, or for tendons and ligaments. They present numerous differences in their degree of projection according to the sex, age, and muscular development of each individual. Their form is equally various. Some consisting of diffused asperities, others extending along the surface like rough lines, whilst others project more or less from the bone, intended not only to give insertion to muscles, but also to serve the purpose of increasing their power of action by removing their line of direction farther from the axis of the bone.

The eminences of impression are certain prominent lines interposed between depressions on the surfaces of bones. Thus, the shallow pits on the cranial bones corresponding with the convolutions of the brain, and the depressions on the external surface, marking the insertion of muscles, are separated by prominent lines, termed eminences of impression. The expression appears not to have been well chosen; it was originally founded on the supposition that the action of contiguous organs, by depressing certain parts of the surface of the bone, served to elevate others; but it is far more conformable to what occurs in other structures to refer to the laws of nutrition and growth, (by which different parts are mutually adapted to one another) the inequalities here alluded to, as well as those more prominent points to which muscles are attached. The latter are usually attributed to the action of the muscles drawing them out, and as it were moulding them; but, as Bichât observes, such an opinion founded on what occurs in soft and inorganic substances, ill accords with the known phenomena of vitality. We observe eminences for the insertion of ligaments, which project more than those intended for muscles; for instance, the spinous process of the ischium: there is moreover, no proportion between the elongation of different apophyses, and the power of the muscles attached to them, viz. between the styloid process of the temporal bone and its muscles.

28. The cavities on the external surface of bones are divisible into the articular and non-articular. The former shall be treated of in the next chapter; the latter being very numerous, may be ranged under the following heads. 1st. Those for insertion. 2. For reception. 3. Gliding. 4. Transmission. 5. Nutrition. Those for insertion are well adapted for the attachment of muscle, ligament, &c. by increasing the extent of space allotted for that purpose, inasmuch as a concave surface presents a greater extent than a plane one bounded by the same line. Some of these, as the digastric and pterygoid fossæ by the greater depth at which they allow the muscles to be inserted, increase their power by permitting an elongation of their fibres.

The bones of the skull and face present several instances of cavities of reception. Some correspond with the whole extent of a bone, as the occipital and parietal. Some occur in a particular part only, as the fossa in the nasal process of the superior maxillary bone, and os unguis for the lachrymal sac. 3. Those for gliding are situated about the heads of long bones, being grooves, in which tendons slide, as they pass to their destinations. The formation of these has been attributed to the influence of the mechanical pressure, and friction of tendons. But such a rationale is inadmissible, for they are found in subjects paralytic from infancy, and are by no means proportioned in depth to the force of the muscular exertion which bears upon them. The different configuration of bones should rather be considered as the result of the laws of ossification which preside over the growth and development of the osseous system, and by which its different parts are adapted to their appropriate purposes. The cavities of transmission give passage to vessels and nerves; their form is various, some being mere fissures, others tubular, &c.; to this head are also referrible several of the apertures at the base of the brain.

The foramina of nutrition transmit the vessels intended for the support of the substance of the bones, and of the medulla; they are divisible into three orders. The first usually receive the name of foramina of nutrition, though in strictness it does not belong to them more than to the others; the only difference between them being, that they transmit vessels to supply the medullary membrane, whilst the others give passage to those which are distributed to the substance of the bone. The first set, considerably the largest, are situated towards the middle of the long bones, and penetrate their substance in an oblique direction. The second order of foramina are much smaller, but very numerous; they are most perceptible towards the extremities of long bones, and generally all over the surface of the short and thick ones. But the third are so minute as to be perceptible only by the aid of a glass, by which we can discern them all over the surface.

29. The proper structure of bone is fibrous in its character, in some parts the fibres being closely aggregated together, constitute a firm and compact substance; in others they are separate, so as to enclose spaces or cells, on which depends the porous and spongy appearance of some bones.

The compact substance is so close in its texture, that the naked eye can discover no interstices in it, yet by the aid of a microscope, a great number of minute vascular canals become perceptible. In the long bones, these canals are all longitudinal, and maintain a free communication laterally with the great medullary canal, and externally with the vessels on the surface of the bone.

The spongy, or cellular part presents a multitude of spaces of various forms and size, all of which communicate with one another, as may be proved by the following experiment: if the end of a long bone, or the surface of a flat one, be perforated, and some mercury poured in, it will be found not only to descend through the cells, but also to flow out through the vascular foramina on the surface. The interior of flat and short bones then, does not differ so decidedly from that of cylindrical ones, as would at first sight appear. Each presents a cavity, which in the one at least towards its centre, is a hollow tube, but in the other is divided, by a number of intersecting laminæ, into minute spaces communicating freely with one another.

Some peculiarities are observable in the arrangement of the compact and cellular structure in the different classes of bones. The body of long bones consists chiefly of the compact substance, but the inner side of the tube is rendered rough by projecting filaments and lamellæ; towards their extremities the compact substance is gradually reduced to a thin lamella, or layer, encasing the bone, the interior of which consists altogether of the cells communicating freely with the large central cavity.

The two surfaces of the broad and flat bones are compact in their texture, the interval between them being made up of spongy substance. This is usually called diploë. The internal table of the cranial bones is more dense than the external, and from being also more thin and brittle, it is called vitreous. The short bones are made up for the most part of spongy substance, encased by a thin lamella of compact tissue. These differences arise altogether from the mode of aggregation and arrangement of the osseous particles, for on examination the composition of both is found to be the same, being made up of the same elements, viz. a cellular base, in the areolæ of which is deposited a peculiar earthy salt.

These constituents may be separated, so that each may be examined by itself. If a bone be macerated for some days in a dilute acid, the saline, or inorganic part is removed, whilst the organic remains; the bone is thus rendered soft and flexible, but retains its form, its weight being diminished in proportion to the quantity of saline matter taken up by the acid; when reduced to this state, it presents no appearance of any particular arrangement of fibres, but by a continued maceration in water, it may be resolved into layers, each of which will be found to consist of a series of fibres aggregated together. If the process be still continued, the fibres become swollen and softened, and present an areolar texture analogous to that of cellular tissue in other parts of the body. This then may be considered as forming the nidus for the deposition of that inorganic substance, on which the solidity and firmness of bone depend. If a cylindrical bone be examined in this way, its central portion is found to consist of several laminæ, super-imposed one on the other; the external one is continuous throughout its whole extent, forming its general envelope, but those subjacent to it, as they pass from the centre, become gradually thinner, and turn inwards towards the axis of the bone, becoming continuous with the lamellæ which divide it into areolæ or cells. In the flat and irregular bones, the compact structure which encloses them externally, sends off filaments and plates to divide their interior into cells or diploé.

30. By long continued boiling, as is well known, a large part of the animal matter of bone is extracted, and a solution obtained, which concretes on cooling into a gelatinous mass. Again, if a bone be exposed to heat so as to expel all the animal matter, it is rendered brittle and light, but still retains its form; but if the heat be raised until the bone becomes red, it undergoes a semi-fusion, as occurs in

other earthy substances under the same circumstances. The analysis of bone affords the following results.

According to Fourcroy and Vauquelin.

Animal matter	51
Phosphate of lime	37·7
Carbonate of lime	10
Phosphate of magnesia	1.3
	100

According to Berzelius.

Cartilage	32·17
Blood-vessels	1·13
Fluate of lime	2
Phosphate of lime	51·09
Carbonate of lime	11·30
Phosphate of magnesia	1·16
Soda, muriate of soda, and water	1·20
	100

The general results of these analyses serve to shew that the fibrillæ into which bone may be divided by maceration, consist of a cellular tissue, containing in its areolæ a quantity of earthy salts.

Respecting its ultimate fibre, several fanciful notions have been entertained by different persons. Thus it was considered by one to consist of absorbent vessels, filled with phosphate of lime. Others thought it to be made up of lamellæ and fibres, between which was interposed an osseous juice, &c. Such gratuitous assumptions serve no other end than to lead inquiry out of the true path, and to retard, instead of promoting, the progress of useful knowledge.

31. Of all the systems of organs, the osseous is that which arrives latest at its full period of development, the progress

of ossification not being fully completed in the different parts of the skeleton, until about the sixteenth or eighteenth year; sometimes even still later. From its first commencement to its final completion, the ossific process runs through three distinct states or conditions, viz. the mucous, cartilaginous, and finally, that of solid bone. But though these succeed one another regularly, it would be a mistake to suppose that the mucus becomes hardened into cartilage, or the latter solidified into bone by any process similar to transformation; the facts observed by no means warrant such an inference. The change coincides with an alteration in the mode of nutrition in the part, in consequence of which bone is deposited in place of cartilage.

The embryo at the earliest periods in which it has been examined, presents no distinction of parts, all being equally soft and homogeneous. So at least it has appeared to the greater number of those who have investigated the subject. Sir E. Home, however, states that several parts are distinguishable, even so early as the eighth day after conception. Towards the fourth week the consistence of the parts corresponding to the future skeleton, is sufficiently increased to admit of their being distinguishable from all others, and their outline defined. The vessels at this period convey and deposit gelatine, the basis of the cartilaginous state, which appears to be completed about the eighth week; for it is about that period that the deposition of bone begins in some places. The cartilages being temporary substitutes for bone, differ from it in many respects. They present no appearance of fibres or vessels, have no internal cavity or medullary tissue; they are solid and homogeneous in their whole extent, but possess the outward form of bone, and are invested by a fibrous envelope analogous to that of bone (perichondrium). There is another peculiarity which deserves notice; all those parts of the cartilage which are intended to be replaced by flat bones, viz. of the skull, face, and pelvis, represent a continuous layer, without any perceptible boundary or distinction, and the fibrous envelope passes uninterruptedly over the entire surface, but the femur, tibia, clavicle, and humerus, are quite distinct and accurately defined; the latter, it will be recollected, are ultimately to be connected by ligaments, and contribute to form the moveable articulations, the former still continue to be united by cartilage. About the eighth week the cartilage, which for a certain time, more or less in different instances, occupies the place and performs the functions of bone, becomes hollowed into irregular cavities, and shortly afterwards into canals lined by vascular membranes, and filled by a mucilaginous or viscid fluid; at this period a red dot appears at some particular point, and ossification immediately commences. The spot first ossified (*punctum ossificationis*) is always situated within the substance of the cartilage, never at its surface. Bichât was of opinion that the vessels were not developed at this period; that they existed before, but circulated only white fluids, and then for the first time begin to admit red globules; but be that as it may, the change is marked by the admission of blood into the interior of the cartilage, and the deposition of calcareous matter, both appearing to be coincident. The cartilage appears red and injected, where it is in close contact with the ossified points; more externally it is somewhat opaque, and marked by grooves or canals; in the next remove it retains its original character, presenting however, in a few points, some vascular canals directed towards the centre of ossification. As the process proceeds, the osseous point increases, as well by additions externally, as by interstitial depositions, whilst the cartilage, as it becomes excavated by canals and cavities lined by vascular lamellæ, diminishes gradually as the bone increases, and finally disappears, being as it were supplanted.

Though this is to be considered merely as an outline of the process of ossification, we cannot enter farther into the subject, as it would lead us too much into detail to enumerate the various peculiarities observable in the different orders of bones.

32. The bones are invested externally by a fibrous membrane (*periosteum*), and lined internally by another which secretes the medulla that fills their cavities. The existence of the medullary membrane in the interior of long bones, may be demonstrated by sawing the shaft across, and exposing it to heat, which will crisp the membrane, and cause its separation from the inner surface of the bone. Its form is tubular, the external surface being connected by minute filaments with the compact texture of the bone, whilst from the internal, thin lamellæ pass inwards and interlace with one another so as to form cells or areolæ, similar to those in the cellular or adipose tissue in other parts. Towards the extremities of the bones, the medullary membrane appears to be continuous, with a similar lining of the different cells, but their extreme tenuity renders it very difficult to demonstrate the fact.

The periosteum invests the bones throughout their entire extent, except at their articulating extremities; but though its continuity is interrupted at the moveable articulations, the membrane passes over the immoveable ones, and assists in maintaining the connexion between their parts; its external surface is rough, flocculent, and covered by a number of filaments, by which it is connected with the surrounding textures, such as muscular fibres, ligaments, and tendons. The internal surface is connected to the bones, both by the vessels which pass into their structure, and by delicate processes of the membrane which accompany them in their course. The connexion is not so intimate in infancy as in adult age. The periosteum not only forms an investment for the bones, but also serves to transmit and support their nutritious vessels; and in infancy, before ossification is complete, it maintains the epiphyses in connexion with the bodies of bones, and gives attachment to tendons and ligaments.

SECTION II.

The Bones of the Trunk.

33. WE commence the osteology with the description of the bones of the trunk, which comprises all those of the vertebral column or spine, of the thorax, and pelvis.

The general Characters of the Vertebræ.

The vertebral column is made up of a range of bones termed vertebræ, from their mobility (*verto*, to turn), of these, twenty-four are separate and moveable upon one another, and thence called true vertebræ; the other five, though originally distinct, become united into one piece, called the sacrum, to the extremity of which is appended the coccyx, consisting of three portions. The parts of the sacrum and coccyx are termed false vertebræ.

The vertebral column, together with the sacrum and coccyx, is situated at the posterior part of the trunk; anteriorly it presents the form of an irregular pyramid; posteriorly along the median line, a series of elongated processes (spinæ), disposed regularly one beneath the other, from which circumstance the term "spine" is derived.

The size of the vertebræ increases from above downwards as far as the first pieces of the sacrum, from which it diminishes towards the end of the coccyx, where it terminates by a point, so that it may be said to consist of two pyramids applied to one another at their bases. The superior or moveable one, however, does not taper regularly from above downwards in its entire length; it becomes somewhat narrowed and constricted as it were, at the third dorsal vertebra, after which it gradually enlarges towards its base.

The true vertebræ are divided into three sets, named from the regions which they occupy, *cervical, dorsal, lumbar.* The sacrum and coccyx which form the remaining part of the column, shall be described with the bones of the pelvis, of which they form an important part. To facilitate the description of these bones, it is necessary to consider in each of them its body, processes, and cavities, or excavations.

The *body* forms the anterior and most considerable part of the bone. It is rounded before, slightly hollowed posteriorly, where it contributes to the formation of the vertebral canal, and in most instances flat on the superior and inferior surfaces, by which it is connected with the contiguous bones.

The *processes* are seven in number, of which four are called articular, from their use, and project, two superiorly and two inferiorly, in order to articulate with the corresponding processes of the contiguous bones. Two others stand outwards on each side, and are called transverse, from their direction. The seventh, situated posteriorly, is termed spinous, from its figure. The union of the spinous with the other processes is effected by means of two plates of bone, the lamellæ, or arches, which complete the central foramen. As the vertebræ are piled one over the other to form a pillar, their foramina are arranged so as to form a continuous canal for the secure lodgment of the spinal marrow and its vessels. The canal varies both in size and form in the different regions. It is broad and triangular in the cervical, narrow and circular in the dorsal; it expands again in the lumbar, from which it gradually diminishes, and ends opposite the third piece of the sacrum by an irregular opening, caused by a deficiency of the spinous processes.

Each vertebra presents two excavations, *or notches*, at each side, one on the superior, the other on the inferior border, the latter being deeper than the former. These are adapted to one another, so that the union of each pair forms a rounded aperture communicating with the vertebral canal, and giving transmission to the spinal nerves. These are called the *inter-vertebral foramina.*

34. This description applies generally to all the verte-

bræ, but as each class presents peculiar characters, which distinguish those included within it from others, and as there are peculiarities which mark certain individuals of each class, it becomes necessary to examine them more in detail.

a. The *cervical vertebræ* are seven in number; the size of their body and processes is less than that of the corresponding parts in the dorsal and lumbar class. The body, elongated transversely, is thicker anteriorly than posteriorly, and on the sides than in the middle. It is concave on the superior, and somewhat convex on the inferior surface. The spinous process is short, projects horizontally backwards, and is bifid at its extremity. The arches are narrower and longer than in the other regions, the transverse processes short, and bifid at their extremities, present a groove superiorly for the transmission of the nerves, and at their base are pierced by a foramen, through which passes the vertebral artery. The superior articular processes are flat, and look backwards and upwards, the inferior downwards and forwards. The vertebral foramen is of a triangular form, and larger proportionally than in the other classes; the inferior grooves for the transmission of the nerves and vessels are deeper and larger than the superior.

b. The *dorsal vertebræ*, twelve in number, are intermediate in size as well as in situation, between the cervical and lumbar. The depth of the body taken from before backwards, is greater than its breadth from side to side. It is convex, and prominent on the anterior surface, flat and plane on the superior and inferior. At each side may be observed a slight notch in the superior as well as in the inferior border; these, when the vertebra is placed in apposition with the adjacent ones, form oval depressions for the reception of the heads of the corresponding ribs. The spinous processes, elongated and triangular, are directed downwards and terminate in a tubercle. The arches are broad and thick; the transverse processes are long, and inclined backwards, and on the anterior surface of their tubercular termination, is situated a slight excavation, which in the fresh state is tipped with cartilage, and articulates with the tubercles of the ribs. The articular processes are vertical in their direction, the superior ones looking backwards, the inferior forwards. The lateral notches, and consequently the inter-vertebral foramina which they form, are larger than those in the neck.

c. The *lumbar vertebræ*, five in number, are larger than the dorsal. The body broader from side to side, than from before backwards, is flat on its superior and inferior surfaces. It is not so convex anteriorly as that of the dorsal vertebræ. The spinous process is broad, flat, and nearly of a square form, so that it terminates not by a pointed extremity, as in the other regions, but presents rather a thick, rounded, and rough border. The arches, though shorter, are deeper and thicker than those of the dorsal vertebræ. The transverse processes long, thin, and horizontal, project forwards more than those of the back. The articulating processes are thick, strong, and disposed vertically, the superior pair concave, look inwards, the inferior convex, outwards. The notches and inter-vertebral foramina are very large.

35. The first, second, and seventh cervical vertebræ present certain characters which distinguish them from the others.

The first, or *Atlas*, so called from supporting the head, is an irregular ring of bone, which presents nothing analogous either to the body or spines of the other vertebræ. It is thicker at the sides where the articular processes are situated, than in any other part of its extent; viewed from before backwards, it presents a small arch of bone, the anterior surface of which is marked by a tubercle, the posterior by a smooth depression, adapted to the odontoïd process of the axis. The posterior segment of the ring is considerably larger; it is thick and round in the greater part of its extent, but at its junction with the rest of the vertebræ, a smooth and slightly excavated surface may be observed on its upper border, marking the course of the vertebral artery. The articulating processes are horizontal and large, the superior pair, which receive the condyles of the occipital bone, oval and concave from before backwards, look inwards towards one another, but the inferior are flat, and nearly circular in their form; finally, the transverse processes project considerably on each side, and terminate in a point. The ring, in the fresh state, is divided into two parts by a transverse ligament, the anterior one being occupied by the odontoïd process of the axis, the posterior by the medulla spinalis.

The *second vertebra*, or *Axis*, (so called from forming the pivot on which the head rotates) is somewhat triangular in its form. The body presents anteriorly a vertical ridge, bounded on each side by a depression for the attachment of the longus colli muscle; superiorly it is surmounted by a process (*dentata, odontoïd*) presenting two smooth surfaces, one for its articulation with the axis, the other with the transverse ligament which retains it in its situation. The spinous process is thick, and grooved on its inferior surface. The superior articulating processes are nearly horizontal, the inferior flat, and directed downwards and forwards. The transverse process is neither grooved nor bifurcated, and the foramen at its root is inclined obliquely outwards.

The *seventh*, or prominent vertebra, approaches in its characters to those of the dorsal region; its spinous process is long, and terminates in a tubercle, and its transverse process presents no foramen.

The *first dorsal vertebra* is marked at each side by a complete articular surface for the first rib, and on its inferior border by a slight excavation, which receives half the head of the second; the articular processes are oblique, and the spinous more nearly horizontal than any of the rest.

The *tenth dorsal vertebra* is usually marked by an articular surface, which receives the entire of the head of the corresponding rib.

The *eleventh* is distinguished by its transverse processes not presenting an articulating surface for the tubercle of the rib, whilst the form of its spinous process and body approaches that of the lumbar vertebræ.

The *twelfth* dorsal vertebra resembles the eleventh in most of its characters; but its transverse processes are longer and thinner, and the inferior articular convex, and directed outwards, so that its conformation resembles that of the lumbar vertebræ in these particulars. Amongst the lumbar vertebræ, the fifth only is distinguishable by any peculiarity deserving of notice, its body being thicker anteriorly than posteriorly, and its transverse process short, thick, and rounded.

36. The bones just described, when ranged in their natural position, form a pyramid, the length of which is equal to about one third of the height of the body; taken as a whole it presents an anterior and posterior surface, two lateral ones, a base, and a summit, each deserving a particular notice.

The *anterior surface* is broad in the cervical, narrow in the dorsal, and again expanded in the lumbar region; it is marked by a series of transverse grooves corresponding with the centre of the bodies of the vertebræ, and in the fresh state is covered by the anterior common ligament. When viewed in profile it presents three curves depending on the different degrees of thickness of the anterior and posterior part of the bodies of the vertebræ in the different regions, and also on that of the inter-vertebral substance. In the neck and loins the convexity of the curve is forwards, in the back it is in the opposite direction. A slight degree of lateral curvature is also observable in most cases in the dorsal region, the convexity of which is directed towards the right side. The older anatomists imagined this to be produced by the action of the aorta beating against the left side of the column; but Bichât attributed it to the effect of muscular action, and explained it in the following way:—As most persons are disposed to use the right arm in preference to the left, the muscles of that side become stronger, and act with more power on the points to which they are attached; when making efforts, as in pulling, the body is curved to the left, which gives an additional advantage to the muscles; and the habitual use of this position determines some degree of permanent curvature. In support of this explanation of the fact, Beclard has stated, that he found in one or two individuals whom he knew to have been left-handed, the convexity of the lateral curve directed to the left side.

The *posterior surface* presents along the median line the spinous processes, disposed in a regular series, varying in form and direction, as has been already stated, being horizontal in the cervical and lumbar regions, and nearly vertical in the dorsal. On each side of these are the vertebral grooves, extending from the base of the skull to the sacrum, which are filled up with the sacro-lumbalis, longissimus dorsi, multifidus spinæ, &c.

The *lateral surfaces* present the transverse processes, varying in form and character in the different regions; before these are situated the inter-vertebral foramina, and more anteriorly still, in the dorsal region, the articulating surfaces which receive the heads of the ribs.

The *summit* is articulated with the occipital bone, and supports the head, whilst the base, or broader extremity, rests on the sacrum. Along the entire extent of the column runs the vertebral canal, which is broad and triangular in the cervical and lumbar regions, circular and contracted in the dorsal.

Of the Thorax.

37. Into the composition of the thoracic portion of the skeleton, enter the sternum and ribs, which are proper and peculiar to it, and the vertebræ, which are common to it

and other parts. The latter have been described in the preceding pages.

The Sternum.

Situated in the median line, at the fore-part of the thorax, this bone is flat and elongated in its general outline, broad superiorly, contracted in the middle, and terminating in a point. We have to consider successively its surfaces, extremities, and borders.

The anterior *surface* subjacent to the skin, gives attachment to the aponeuroses of the pectoralis major and sterno-mastoïd muscles; and is marked by four transverse lines, indicating its original division into five pieces.

The *posterior surface* looks backwards, towards the cavity of the thorax, and gives attachment superiorly to the sterno-hyoïdeus, and sterno-thyroïdeus muscles, inferiorly to the triangularis sterni. Along the middle line it corresponds with the interval left by the divergence of the pleuræ.

The *borders* are thick, and marked by seven depressions, for the reception of the cartilages of the true ribs, which give them a notched or serrated appearance.

The *superior extremity*, broad and thick, is slightly excavated from side to side, and presents at each corner a depression for the reception of the sternal end of the clavicle.

The *inferior extremity*, thin and elongated, gives attachment to a cartilaginous appendix, called the ensiform cartilage, which in most cases remains in the cartilaginous state, until an advanced period of life. It is sometimes bent forwards, sometimes in the opposite direction, and often pierced by a hole at its centre. Its form varies considerably in different individuals; it gives attachment to the aponeuroses of the abdominal muscles. The sternum, in early infancy, is divided into several pieces, but in adult age two only remain distinct. The first division of the sternum is larger and thicker than the other; its form is nearly square; its lateral margins thin and oblique, present each an oblong depression, which receives the cartilage of the first rib. And at each inferior angle may be observed an articular half notch, which articulates with the second rib. The superior border is hollowed, as has been already stated; the inferior is straight, and united to the extremity of the second bone.

The *second piece,* much longer than the first, is marked on its anterior surface by some transverse lines, which indicate its original division into separate portions. Both surfaces are depressed and nearly flat. The upper border is narrow, corresponding in breadth with the termination of the first bone, with which it is connected by cartilage. The lateral margins present each five notches for the reception of the cartilages of the five lower true ribs, and a half notch superiorly, which with a similar depression in the first piece, forms a cavity for the second costal cartilage. The five inferior notches approach one another more closely, in proportion as they are situated lower down, and part of the last is occasionally made up by the ensiform cartilage.

The Ribs.

38. The ribs are situated between the sternum and vertebral column, and disposed in arches, so as to enclose the lateral parts of the thorax. They are twelve in number at each side, of which each of the seven superior ones, by means of a cartilaginous prolongation, which unites it to the sternum, completely encircles the thorax, on which account they are thence called *true ribs;* the remaining five being denominated *false* ribs, as they do not form complete circles.

The length, breadth, and direction of these bones present several varieties. From the first to the eighth their length successively increases, whilst from the ninth, they gradually decrease, so that the last is very little longer than the first.

Their breadth considered in the whole series diminishes gradually from the first to the twelfth, but in each rib it is greatest towards its sternal extremity.

As to their direction in reference to the vertebral column, the first forms almost a right angle with it, and the succeeding ones gradually incline downwards, so that their anterior extremity is lower than the posterior. The body of all the ribs, except the first, is as it were twisted on itself, so that their two extremities cannot be made to rest at the same time on a plane surface.

These bones present two surfaces, two borders, and two extremities.

The external surface is convex and smooth. The internal is concave, and corresponds with the pleura.

The superior border smooth and rounded, gives attachment to the intercostal muscles; the inferior is marked by a groove for the lodgment of the intercostal vessels, and also gives attachment to the intercostal muscles.

The *posterior extremity*, which articulates with the spinal column, presents a head, which is rounded and undivided in the first, eleventh, and twelfth, but in the others it is divided into two articular faces by a slightly marked ridge; the head is supported by a narrow round part, or neck, terminated externally by a tubercle, which is smooth in one part for its articulation, with the transverse process of the dorsal vertebræ, and rough in the other, for the insertion of the costo-transverse ligament.

The *anterior extremity* is broad, flat, and hollowed at its tip into an oval pit, into which is implanted the costal cartilage.

Between the tuberosity and the most convex part of the body of each rib, is a rough line, marking what is termed its *angle*. The distance of the angle from the tuberosity increases gradually from the first to the eleventh, inclusive. In the last it is not perceptible, in the first it is not distinguishable from the tuberosity.

The two first and the two last ribs present some peculiarities deserving of notice.

The *first rib* is shorter and broader than either of the succeeding ones; its direction is nearly horizontal, its body not being twisted as the others are. The superior or external surface is marked by a smooth depression, over which slide the subclavian vessels; the inferior is slightly hollowed posteriorly, and looks towards the cavity of the thorax. The external border, convex and rounded, is surmounted by the tuberosity; the internal is thin, and forms the margin of the superior aperture of the thorax. The anterior extremity is broad and thick; the posterior is thin and narrowed into the form of a neck; its head presents an undivided articular surface.

The *second rib* is longer than the first, and presents externally a prominent line for the attachment of the serratus magnus; its internal surface is somewhat grooved posteriorly.

The *eleventh* has no groove on its inferior border, nor a tubercle, as it is not articulated with the transverse process; its angle is scarcely perceptible, and the head has but one articulating surface.

The *twelfth* differs little from the preceding one, except in being shorter; it has neither angle, tubercle, nor groove, and as its anterior extremity, which is pointed, seems loose and unattached, it is called the floating rib.

The Costal Cartilages.

39. These cartilages are twelve in number; their breadth diminishes gradually from the first to the last, whilst the length increases as far as to the seventh, after which it becomes less in each succeeding one. Their line of direction also varies considerably. The second one is horizontal,

the first descends a little, and all the rest ascend more and more as they are situated lower down. The external or costal extremity, convex and unequal, is implanted into the end of the corresponding rib. The internal extremity of the cartilages of the true ribs is articulated with the sternum; each of the cartilages of the three first false ribs is attached to, and blended with that which is next above it; in the two last it is pointed and unattached.

Attachments of Muscles. The two layers of intercostals to the contiguous borders of all the ribs: the scaleni to the first and second: the pectoralis major to the cartilages of the true ribs, except the first: the pectoralis minor to the bodies of the third, fourth, and fifth: the rectus abdominis to cartilages of the three last true ribs and ensiform cartilage: the obliquus externus to the three last true ribs, and all the false: the internal oblique and transversalis to the cartilages of the four or five false ribs: the diaphragm to the ensiform cartilage, and to those of the six last ribs.

The serratus magnus to the nine superior ribs: the latissimus dorsi to the four inferior: the serratus posticus superior to the third, fourth, and fifth true ribs: the serratus posticus inferior to the three last: the sacro-lumbalis to the angles of all the ribs: the levatores costarum a little beyond the tuberosities.

Of the Pelvis.

40. The pelvis, or basin-shaped extremity of the trunk, is a deep cavity, formed by the union of the ossa innominata, the sacrum, and coccyx. Its form is somewhat circular; its size presents many varieties, dependant on the age of the subject, as well as on individual conformation. In young subjects the two large lateral bones, the ossa innominata, are divided each into three pieces, the ileum, ischium, and os pubis; the sacrum consists of five pieces, resembling in some respects the bones of the vertebral column, hence called false vertebræ; these, in adult age, become united into one. The coccyx, or caudal prolongation, consists of

three pieces, which usually remain separate to an advanced period of life.

The Sacrum.

41. The sacrum, when the body is in the erect position, is placed at the superior and posterior part of the pelvis, beneath the last lumbar vertebra, which it supports, above the coccyx, and between the ossa innominata, into which it is inserted, in some measure like a key-stone into an arch.

Its figure is triangular in its general outline; concave anteriorly, convex posteriorly. We consider successively its surfaces, borders, and extremities.

The *anterior* surface, flat from side to side, is concave from above downwards, and marked by four transverse lines, indicating its original division into five pieces; laterally it presents four foramina for the transmission of the anterior branches of the sacral nerves. These are directed outwards, and diminish gradually in size from above downwards; external to them is a depressed surface for the attachment of the pyramidalis muscle.

The *posterior* surface is convex, and presents along the median line four small eminences, usually connected so as to form a ridge, these are rudiments of the spinous processes; and beneath them is a triangular groove, marking the termination of the sacral canal: at each side of the median line are two grooves, pierced by the posterior sacral foramina, which are much smaller than the anterior, and transmit the posterior branches of the sacral nerves.

The *borders*, or lateral surfaces of the sacrum, present two distinct parts, one superior, large and irregular, which in the fresh state is covered with cartilage, and articulated with the os innominatum; the other inferior, thin, and narrowing to a point, gives attachment to the sacro-sciatic ligament. A small excavation terminates this border, which with the corresponding extremity of the coccyx, forms a notch for the transmission of the last sacral nerve.

The superior extremity, or *base*, broad and expanded, presents, 1st, towards the middle line an oval surface, cut off obliquely, and tipped with cartilage for its articulation with the last lumbar vertebra; behind this is a triangular aperture marking the orifice of the sacral canal. 2d. On each side a smooth convex surface, inclined forwards, and continuous with the iliac fossæ; an articular process, concave from side to side, which looks backwards and inwards, and receives the inferior articular process of the last lumbar vertebra; this is bounded anteriorly by a groove, forming part of the last inter-vertebral foramen, and posteriorly, by a sharp border, corresponding with the lateral arches of the vertebræ, and giving attachment to the last ligamentum subflavum.

The inferior extremity, or *apex*, directed downwards, presents an oval convex surface, which articulates with the coccyx.

The sacrum gives attachment, by the lateral part of its anterior surface, to the pyramidalis muscle; by its posterior surface to the gluteus maximus, sacro-lumbalis, and latissimus dorsi; by the inferior part of each border to the coccygeus.

The Ossa Coccygis.

42. These, in the adult, are usually found separate, but in old age often united into one. They diminish gradually in size from above downwards, which gives them, when taken together, a pyramidal form. As they are placed in a continuous line with the inferior third of the sacrum, they form a concave surface anteriorly, a convex one posteriorly.

The first of these bones resembles, in some measure, the last false vertebra of the sacrum. Its body, or central part, is small; but, posteriorly and on each side, two small eminences, termed cornua, project, which articulate with the extremity of the sacrum. The second bone of the coccyx is somewhat square; the last elongated.

Attachments of Muscles. The coccyx gives attachment to the gluteus maximus, to the coccygeus, and by its point to the sphincter ani.

The Os Innominatum.

43. To facilitate the description of this very irregular bone, it is convenient to consider separately each of the parts into which it is found divided in early life, viz. the ileum, os pubis, and ischium.

The *ileum*, or superior, and expanded part of the bone, is broad, flat, somewhat triangular in its form, and situated at the superior and lateral part of the pelvis. Its surfaces, borders, and angles, must be considered successively.

The external surface, convex before, concave posteriorly, is marked by two curved lines running from before backwards, the superior being the longer. On its superior and posterior part is observed a rough surface, which gives attachment to the gluteus maximus muscle. The internal surface is divided into three parts. One anterior, smooth, and concave, is called the iliac fossa, the other posterior, is rough, and serves for its articulation with the sacrum, whilst the third is smooth, much smaller than the others, and is the only part that enters into the formation of the true pelvis.

The *superior border*, extending from before backwards, is somewhat arched; it forms an epiphysis in infancy, and is sometimes called the spine of the ileum, but more properly its crista; its anterior extremity curves inwards, the posterior outwards. This border presents an external and internal lip, and a rough interval, to each of which muscles are attached.

The *anterior border*, depressed and excavated, descends from the superior border towards the pubis, with which it is continuous; its junction with the former is marked by a prominent point, called the *anterior superior spinous process;* and that with the latter, by a slight eminence common to the two bones, called the *ileo-pectineal* eminence. This border presents two excavations, separated by a prominent point, called the *anterior inferior spinous process.* The interval between the latter, and the ileo-pectineal eminence, gives transmission to the iliacus and psoas muscles.

The *posterior border* also presents two notches, separated by a prominent point of bone, called the *posterior inferior spinous process;* above which is another bony eminence, called the *posterior superior spinous process;* of the notches, the inferior and larger one contributes to form the sacro-sciatic notch.

Of the three angles of the bone, the two superior ones correspond with the spinous processes. The inferior is represented by the constricted part of the bone. Here we observe three surfaces, one external, smooth, concave, forming part of the *acetabulum,* the deep cavity which receives the head of the femur; one anterior, small, and triangular, marking the junction with the pubis, a third posterior, the junction with the ischium.

Attachments of Muscles. To the interval, on its external surface, between the crista and superior curved line, is attached the gluteus medius: to the space, between the latter and the acetabulum, the gluteus minimus: to the posterior rough surface, the gluteus maximus: to the internal surface, or iliac fossa, the iliacus muscle.

To the anterior half of the external lip of its crista is attached the obliquus externus abdominis: to the posterior third of the same lip, the latissimus dorsi: to the anterior three-fourths of the inner lip, the transversalis abdominis: to the anterior two-thirds of the interval between the lips, the obliquus internus, and to the remainder, the quadratus lumborum.

To the external surface of the anterior superior spine is attached the tensor vaginæ femoris: to the notch, beneath it, the sartorius: to the anterior inferior spine, the straight tendon of the rectus femoris; and to the brim of the acetabulum, the external tendon of that same muscle.

The Os Pubis.

44. This bone forms the anterior and internal part of the os innominatum; and is usually divided into two parts, one superior, and thick, called the *body,* the other inferior, and thin,—the *ramus.*

The body, horizontal in its direction, and prismatic in its form, presents three surfaces, separated by three prominent lines. The superior surface, slightly depressed, is covered by the pectineus muscle; the internal is smooth, and forms part of the pelvic cavity; the third inferior, and somewhat grooved transversely, inclines downwards, to the thyroïd foramen.

The external extremity of the bone is thick, and presents three faces; one, concave, forms part of the acetabulum; another, superior, connects it with the ileum (the junction being marked by a slight elevation, called the *ileo-pectineal eminence*); the third, inferior, is joined with the ischium. The internal extremity, flat and compressed, is joined to the corresponding part of the opposite bone, by an intervening cartilage, the junction being termed the *symphysis pubis.* Leading outwards from the symphysis, whose direction is vertical, may be observed another margin, nearly an inch in length, which is placed horizontally, and named the *crista.* The angle formed by the crista and symphysis, is termed the angle of the pubis; the crista is terminated externally, by a projecting nodule of bone—the *tuberosity* or spine, from which runs outwards a sharp line, (*the ileo-pectineal line*) giving attachment to Gimbernat's ligament, and to the pectineus muscle, and marking the margin of the pelvis.

The *ramus* descends outwards and downwards from the body, forming an angle with it, becomes thin, and unites with the ascending ramus of the ischium. The inner surface is smooth, the external is rough, for the attachment of muscles. One of its borders, thick and rough, forms with the opposite bone an arch, called the arch of the pubis;

the other border, sharp and thin, forms part of the margin of the foramen thyroïdeum.

Attachments of Muscles. To the crista is attached the pyramidalis and rectus abdominis; to the tuberosity and anterior surface, the obliquus externus; to the pectineal line, the pectineus and Gimbernat's ligament; to the crista, and part of the same line, the obliquus internus and transversalis.

To the external surface, at the angle, the adductor longus; to the space between this and the border of the thyroïd foramen, the adductor brevis; to the line of the symphysis and the ramus, the gracilis; and to the whole margin of the foramen, the obturator externus. To the inner surface, the obturator internus and levator ani.

The Ischium.

45. The *ischium* forms the lowest and posterior part of the os innominatum; it consists of two parts, a body and a ramus, united at an angle, so as to give the bone somewhat the figure of a hook. The *body*, or larger part, presents an external and an internal surface, two borders, and two extremities. On its external surface may be observed a smooth concave part, which forms more than two-fifths of the acetabulum, and is surrounded by a prominent line, marking the border of that cavity; beneath this is a groove, directed horizontally, corresponding with the tendon of the obturator externus muscle, and also a rough line, which passes downwards to the tuberosity of the ischium, and gives attachment to the quadratus femoris. The anterior border, thin and sharp, bounds the thyroïd foramen; the posterior, broad and expanded, is divided into two parts by a projecting process, (*spinous process of the ischium*) of which the superior one, flat and smooth, presents nothing deserving particular notice; the inferior, rounded and excavated, forms a pulley-like surface, on which the tendon of the obturator internus muscle runs. The *tuberosity*, thick and rounded, forms the part on which the body is

supported in the sitting position. On the superior extremity of the bone, (if it be examined in early life, or after a section has been made of the os innominatum, so as to divide it into its three parts) three surfaces may be observed, of which two are flat and triangular, and mark its junction with the ileum and os pubis; the other, concave and smooth, forms part of the acetabulum. The inferior extremity is identified with the tuberosity, presents two rather rough borders, and an intervening space, and is marked by three muscular impressions. The *ramus* of the ischium is the flat, thin part, which ascends forwards and inwards from the tuberosity, towards the ramus of the pubis with which it is united. One margin of the ramus forms part of the inferior outlet of the pelvis, the other of the thyroïd foramen.

Attachments of Muscles. To the ramus is attached part of the gracilis; to its external surface, and to the border of the tuberosity, the adductor magnus; to the inner margin of the tuberosity, the erector penis; to the adjacent margin of the ramus, the transversus perinei; the internal and external obturator muscles to the corresponding surfaces of the bone round the thyroïd or obturator foramen.

To the posterior surface of the tuberosity, the three flexors of the leg, *scil.* the biceps, semi-tendinosus, and semi-membranosus; to the rough line, leading from the acetabulum to the tuberosity, the quadratus femoris; to the external surface of the spine, the gemellus superior; to the adjacent border of the tuberosity, the gemellus inferior; to the internal surface of the bone, the levator ani; and to the spinous process, the coccygeus.

At the junction of the three pieces of the os innominatum is situated the acetabulum, or cotyloïd cavity, which articulates with the head of the femur; of this the ischium forms somewhat more than two-fifths, the ileum somewhat less than two-fifths, and the remainder is made up by the pubis. It is surrounded in the greater part of its extent by a margin or supercilium, which is most prominent towards the superior and external part, but at the opposite point, or towards the thyroïd foramen it is deficient, leaving a notch. The greater part of the cavity is covered with cartilage in the natural condition; but towards the notch there is a part depressed beneath the rest, and which corresponds with the passage of the round ligament, and lodges some synovial cryptæ; this has no cartilaginous coating.

General Conformation of the Pelvis.

46. The *pelvis,* thus made up of the ossa innominata, the sacrum, and coccyx, deserves to be attentively examined, not merely as to the details of the parts which compose it, but as to its general conformation. Taking the objects which are deserving of notice, from before, backwards, and beginning, at the median line, we observe the *symphysis* pubis, or the line of junction between the two bones of that name—on the sides, the thyroïd foramina and the acetabula. Posteriorly, along the middle line, are situated the tubercles or spinous processes of the sacrum; external to these, the posterior sacral foramina, and next, a broad, unequal surface, to which the sciatic ligaments and gluteus maximus are attached; and lastly, the deep excavation, (sacro-sciatic notch) bounded by the contiguous margins of the sacrum and os innominatum.

The internal surface is divided into two parts by a prominent line, (*linea ileo-pectinea*) leading from the tuberosities of the ossa pubis, outwards and backwards, to the prominent point of the sacrum (*promontorium*). This constitutes the margin of the true pelvis, all the part above it being called the false pelvis, as in reality it belongs to the abdomen.

The superior circumference of the pelvis is formed on each side by the crista ilei; posteriorly, may be observed a deep notch, which is divided into two parts by the base of the sacrum, and anteriorly is an extensive excavation, bounded on either side by the anterior-superior-spinous processes of the ilea, and thence descending towards the symphysis pubis. The inferior circumference, or outlet, presents three deep notches; of which the anterior one, triangular in its form, is bounded on each side by the rami of the ichia and pubis, extending upwards and inwards, from the tuberosities of the ischia to the pubic arch. The two other notches, (*sacro-sciatic*) are placed behind and above the tuberosities, and correspond with the interval between the sacrum and os innominatum. When examined in the dried bones their extent is considerable, but in the natural condition they are divided into lesser spaces by the sacro-sciatic ligaments.

The size and conformation of the pelvis differ very remarkably in the two sexes. In the female, though its perpendicular depth is less, its breadth and capacity are greater. The alæ of the iliac bones are more expanded; the upper aperture is more nearly circular, the projection of the sacrum less perceptible; and the space between the tuberosities of the ischia greater. The depth of the symphysis pubis is less in the female than in the male, whilst the breadth of the pubic arch is greater.

In the erect attitude of the body, the direction of the pelvis is oblique, its upper aperture being inclined forwards; so much so, that if a line be drawn from the upper border of the symphysis pubis, backwards, to the sacrum, it rests against the middle of that bone. In consequence of this inclination, the central line or axis of the inlet, differs very decidedly from that of the outlet; the former, if drawn from above downwards, reaches the lower third of the sacrum, the latter, if drawn from below, backwards and upwards, touches the promontory of the sacrum; both therefore decussate towards the centre of the pelvic cavity.

The different dimensions of the male and female pelvis are stated by Meckel* as follows:

		In the male pelvis.		In the female pelvis.	
		inch.	lines.	inch.	lines.
Between the anterior-superior-spinous processes of the ilea		7	8	8	6
Between the middle points of the cristæ of the ilea		8	3	9	4
The transverse diameter	of the inlet	4	6	5	0
The oblique		4	5	4	5
The antero-posterior		4	0	4	4
The transverse diameter	of the cavity	4	0	4	8
The oblique		5	0	5	4
The antero-posterior		5	0	4	8
The transverse	of the outlet	3	0	4	5
The antero-posterior		3	3	4	4

The last may be increased to five inches in consequence of the mobility of the coccyx.

The Bones of the Lower Extremity.

47. The lower extremity is made up of three parts; the thigh, leg, and foot.

The osseous part of the first consists of one bone, the femur; that of the leg, of two, the tibia and fibula. The adjacent extremities of these, together with the patella, (a sort of sesamoïd bone) form the knee.

The foot is composed of three parts; the tarsus, metatarsus, and phalanges.

The Femur.

48. The femur is the longest bone in the skeleton; it presents a central part, or body, and two extremities.

The *body*, compressed, but nearly cylindrical towards the centre, is expanded superiorly and inferiorly. Its anterior surface, convex and smooth, is necessarily broader towards the extremities of the bone than at the centre. Both the lateral surfaces are compressed and somewhat flat; but it may be observed that the external is broader than the internal, particularly towards the superior part. The anterior is separated, though not in a very marked degree, from the lateral surfaces by two lines, which may be traced upwards from the condyles, towards the superior extremity of the bone; but posteriorly at the union of the two lateral surfaces, is a rough and prominent line, the *linea aspera*, which gives attachment to several muscles.

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* Tom. i. p. 743.

The linea aspera is most prominent towards the centre of the bone, and when examined with attention, presents two lips and a rough interstice, each giving attachment to muscles. Above and below this part it subsides as it were towards the extremities, and also becomes bifurcated. The two superior divisions or branches of the line terminate, the one (internal and somewhat shorter) at the lesser trochanter, the other, external, at the greater trochanter. The inferior divisions spread more asunder, and terminate at the condyles, enclosing between them and the margins of these prominences, a flat triangular portion of the bone, which corresponds with the popliteal vessels. Towards the superior part of the linea aspera may be observed a foramen directed from below upwards, intended to transmit the medullary vessels.

The *superior extremity* presents three eminences, differing in size, form, and direction. Two of these give attachment to muscles, the third constitutes the articular head of the bone. The first of these is called the *trochanter major*, which is continuous with the external surface of the bone, and nearly in a line with its axis. This apophysis, quadrilateral in its form, is convex and rough on its external surface; the internal one, of less extent, presents at its base a pit, which receives the external rotator muscles; the superior, or terminal border is flat and straight, and the posterior thick and rounded. At the posterior aspect of the great trochanter, may be observed an oblique and prominent line, directed downwards and inwards, and terminating in an eminence of much less size, called the trochanter minor.

The *trochanter minor*, a conical rounded eminence, projects from the posterior and internal side of the shaft of the bone, and gives attachment to the tendon of the psoas and iliacus muscles.

At the inner side of the great trochanter, and above the lesser, projects upwards, inwards, and a little forwards, an elongated process, forming the neck of the bone, which terminates in a rounded globular head. The line of direction of the neck forms an obtuse angle with the axis of the femur; its anterior surface is broad and smooth, the superior, inclined upwards, is somewhat concave; the inferior is the most extensive. The union of the neck with the rest of the bone, is marked by two oblique lines, one anterior, the other posterior, proceeding from the trochanter major; to these is attached the capsular ligament. The neck is surmounted by a globular head, which forms a considerable segment of a sphere, is tipped with cartilage in the fresh state, and lodged in the acetabulum. A little beneath its most prominent point is a small cavity, which gives attachment to the round ligament.

The *inferior extremity* of the bone, much thicker and broader than the superior, is terminated by two eminences, separated posteriorly by a deep fossa; these are named *condyles*, of which one is internal, the other external.

The external is larger, and projects forwards more than the internal; its articulating surface also is broader and mounts higher up; the external surface, rough and unequal, presents a deep pit inferiorly, which gives attachment to the tendon of the popliteus muscle.

The articular surfaces of both, covered with cartilage in the fresh state, are united anteriorly, where they form a pulley-like surface, concave from side to side, on which the patella glides. Inferiorly, these surfaces diverge as they pass backwards, and when they terminate at the posterior surface of the bone, are separated by a considerable interval.

The internal condyle appears longer, and also to descend lower down than the other; but this is rather apparent than real, for by means of the obliquity of the shaft of the bone, both condyles are brought to the same plane. The internal condyle presents at its inner side a tuberosity, which gives attachment to the internal lateral ligament and the tendon of the adductor magnus. The external presents also a tuberosity for the external lateral ligaments. In the fossa between the condyles, are implanted the crucial ligaments.

Articulations. The femur articulates superiorly with the acetabulum, inferiorly by its condyles with the tibia, and anteriorly with the patella.

Attachments of Muscles. To the anterior and two lateral surfaces, and to both lips of the linea aspera, is attached the triceps extensor; to the centre of that line, the adductors and short head of the biceps flexor; to the superior border of the trochanter major, the gluteus medius; to its anterior border, the gluteus minimus; to the fossa at its inner surface, the external rotators; to the lesser trochanter, the tendon of the psoas and iliacus; to the line between the trochanters, the quadratus femoris; to the line below the lesser trochanter, the pectineus; to the rough line descending from the great trochanter, the gluteus maximus; just above the condyles, the gastrocnemius; to the external condyle, the plantaris; to the fossa beneath the external tuberosity, the popliteus.

The Patella.

49. The patella is situated at the anterior part of the knee joint, being attached by a ligament (*ligamentum patellæ*) to the tibia, so that its position varies according to the movements of that bone. Compressed and somewhat triangular in its form, its anterior surface is convex, and co-

vered by the expanded fibres of the extensor tendons; the posterior smooth, and covered with cartilage for its articulation with the condyles of the femur, is divided into two parts by a vertical line, the external being the broadest. Beneath these is situated a small irregular depression, corresponding with the apex, or narrowest part of the bone, which gives attachment to the ligamentum patellæ. The superior extremity, broad and rounded off at its margin, gives attachment to the extensor muscles; the inferior, narrow and pointed, to the ligament already named; the lateral borders are convex, the external being thinner than the internal.

The Tibia.

50. The tibia next to the femur, is the longest bone in the skeleton; it is situated at the anterior and inner side of the leg, and like the other long bones, is divided into a body and two extremities. The *superior extremity,* thick and expanded, is broader from side to side, than from before backwards; its circumference is somewhat rounded and convex in front and at the sides, but slightly hollowed posteriorly; at the fore part is situated an eminence, to which the ligamentum patellæ is attached; on the sides, and above this, are two rounded eminences, called *tuberosities,* the external one being somewhat smaller than the other, and marked on its outer side by a flat surface which articulates with the head of the fibula. These give attachment to the lateral ligaments, and on their superior aspect may be observed two smooth cartilaginous surfaces, (*condyles*) which sustain the condyles of the femur; the internal one is somewhat deeper, its greatest diameter from before backwards, the other being nearly circular. In the interval between the articular surfaces, is situated a pyramidal eminence, the summit of which is usually divided into two tubercles, it is named the spinous process of the tibia; before and behind this are two irregularly depressed surfaces,

which give attachment to the crucial ligaments and to the semi-lunar cartilages. The *lower*, or *tarsal* extremity, is much smaller than the other, and nearly quadrilateral in its form; the anterior surface, convex and smooth, gives attachment to the anterior or tibio-tarsal ligament; the posterior is flat, and marked by a groove for the flexor longus pollicis; the external slightly concave, is rough superiorly, for the attachment of the transverse ligament, and smooth below, to receive the extremity of the fibula. From this end of the bone projects downwards a triangular apophysis, the *internal malleolus;* its inner surface is convex, and merely covered by the skin, the external is smooth, and articulates with the side of the astragalus; the anterior forms a rounded border, whilst the posterior is marked by two grooves for the tendons of the tibialis posticus, and flexor communis; to the most dependent part of the process is attached the internal lateral ligament. The lower articular surface consists of two parts, one vertical, just described as being situated at the outer side of the malleolus; the other horizontal in its direction, concave and quadrilateral in its form, divided into two parts by a slightly raised line; of these two surfaces, which are tipped with cartilage in the fresh state, and united at a right angle, the latter rests on the dorsum of the astragalus, the former applied to its inner flat border.

The *body* of the tibia, triangular in its form, diminishes gradually in size for about two thirds of its length, after which it increases somewhat towards its lower extremity. The *internal* surface is convex and subcutaneous in the greater part of its extent, but its upper part is covered by the tendons of the sartorius, semi-tendinosus and gracilis muscles. The *external* surface, slightly hollowed above, where it gives origin to the tibialis anticus, is convex, and somewhat inclined forwards below, where it is covered by the extensor tendons. The *posterior* surface, not so uniform in its outline as the others, is marked at its upper third by a line extending upwards and outwards to the external tuberosity; the part above this is triangular, and gives attachment to the popliteus muscle, that below it to the tibialis posticus and flexor digitorum, and from the line itself arises the soleus. Near this line may be observed the medullary foramen, its direction being from above downwards. The anterior border, sharp and prominent, particularly towards the middle, is called the *crista* of the tibia; it gradually subsides towards the lower part. The inner border, thick and rounded, gives attachment to the soleus and flexor communis, whilst the external, somewhat sharp, divides inferiorly into two lines, which diverge towards the surface of articulation with the fibula. The interosseous ligament is inserted into this external angle. The body of the tibia is slightly twisted, so that the internal tuberosity inclines backwards, and the internal malleolus forwards, which conformation deserves attention in the diagnosis and adjustment of fractures. The tibia articulates with the femur, the fibula, and the astragalus.

Attachments of Muscles. To the external surface and external tuberosity, the tibialis anticus; to the latter also, the head of the extensor longus digitorum; to the inner surface, the sartorius, gracilis, semi-tendinosus, and semi-membranosus; the popliteus to the triangular space on the posterior surface; the soleus, tibialis posticus, and flexor longus, to the rest of its extent, and through the medium of the patella and its ligament, it may be said to give insertion to the extensors of the leg.

The Fibula.

51. This bone is situated at the external side of the leg; it is nearly equal to the tibia in length, but is much more slender. Its direction is nearly vertical, the lower extremity inclining somewhat forwards. The *body*, irregularly triangular in its form, presents three prominent lines bounding three surfaces; the anterior or most prominent line, gives origin to muscles in the superior part of its extent, and bi-

furcates towards its lower extremity, so as to enclose a slightly concave triangular surface, which is subcutaneous; the internal one also gives attachment to muscles, and inferiorly, where it inclines forwards, to the interosseous ligament. The *internal* surface looks backwards for about a third of its extent, and somewhat forwards in the rest, and is divided, but unequally, into two parts, by a slightly marked longitudinal line, to which the interosseous ligament is attached for about two-thirds of its length; the part of the surface behind this is grooved. The *external* surface is also grooved, and gives origin to muscles; the *posterior*, convex and smooth, serves the same purpose, presents towards its middle a small foramen, directed obliquely downwards for the transmission of the medullary vessels; in the lower part it inclines inwards, and is terminated by a rough surface connected with the tibia.

The *superior*, or tibial *extremity*, is smaller than the other; it presents on the supero-internal part, a small oval, and nearly flat surface, for its junction with a corresponding part of the external tuberosity of the tibia; the remainder is unequal, and gives insertion to the biceps flexor cruris, to the external lateral ligament of the knee joint, and to those which connect the tibia and fibula. The *inferior*, or tarsal *extremity*, forms the external malleolus, which is longer and more prominent than the internal: in front it receives the insertion of ligaments, behind is situated a shallow groove, traversed by the tendons of the peronei muscles; the outer side is convex and subcutaneous; the inner presents a small triangular surface, convex in the perpendicular, and nearly plane in the antero-posterior direction, which articulates with the astragalus, and is bounded posteriorly by a rough depression, affording attachment to the transverse ligament of the ankle joint, whilst the apex gives origin to the external lateral ligament. The fibula articulates at both extremities with the tibia, and at the inferior one with the outer border of the astragalus.

Attachments of Muscles. The internal surface, by its anterior portion, to the extensor communis digitorum, extensor proprius pollicis, and peroneus tertius, by the depression on its posterior part to the tibialis posticus; the external surface, to the peronei; the posterior surface, to the soleus and flexor longus pollicis; its head, to the biceps flexor cruris.

The Bones of the Foot.

The foot is composed, like the hand, of three parts, viz. the tarsus, metatarsus, and toes.

The Tarsus.

The tarsus is composed of seven bones, viz. the os calcis, astragalus, naviculare, cuneïforme internum, cuneïforme medium, cuneïforme externum, and cuboïdes.

The Os Calcis.

52. This bone is situated at the posterior and inferior part of the tarsus, and forms the heel by its projection backwards; elongated in that direction and compressed laterally, it is the largest of the bones of the foot. Superiorly it presents from behind forwards, a concave portion, intervening between the insertion of the tendo Achillis into its posterior border, and the surface which articulates with the astragalus; then the last named surface, which is bounded by a rough depression for the insertion of a ligament (interosseous) and lastly a narrow concave surface, which also articulates with the astragalus. On the inferior surface, which is narrower than the preceding, and broader behind than before, are observed posteriorly two eminences (the internal being the larger) serving for the attachment of muscles; between them a depression for the origin of the long plantar ligament, and in front another eminence, giving attachment to the inferior ligament connecting this bone with the naviculare. The anterior surface, the smallest, is slightly concave, and articulates with the cuboïd bone. The

posterior surface, convex, presents, inferiorly, inequalities for the attachment of the tendo Achillis; and, superiorly, a smooth surface, separated from that tendon by a synovial bursa. The external surface, broader behind than before, presents, in the latter direction, grooves for the tendons of the peronei muscles, and is subcutaneous in the rest of its extent. The inner surface, deeply concave, is traversed by the plantar vessels, nerves, and the tendons of the flexor muscles, and tibialis posticus.

The Astragalus.

53. The astragalus is situated at the superior part of the tarsus; its form is irregular; it appears as if twisted on itself. The upper surface presents, in front, a rough and slightly excavated part, serving for the attachment of ligaments; and behind it a large convex cartilaginous surface, which is longer and more prominent on the outer than on the inner side, broader before than behind, and articulated with the lower extremity of the tibia. On the inferior surface are observed, in front and somewhat internally, a narrow convex surface, and behind, a broad concave one, both articulating with the os calcis; these are separated by a groove, which receives the ligament that proceeds upwards from the last named bone. The anterior surface, convex, articulates with the naviculare. The posterior surface is grooved and traversed by the tendon of the flexor longus pollicis. On the outer and inner sides are situated two surfaces, (the former the larger,) which are in contact with the inferior extremities of the tibia and fibula, forming the malleoli. The astragalus articulates with the tibia and fibula above, with the os calcis below, and with the naviculare in front.

The Cuboïd Bone.

54. This bone is situated at the external side of the tarsus; its form is indicated by its name. The superior sur-

face rather rough, inclined outwards and upwards, gives attachment to ligaments. The inferior surface presents, in front, a depression traversed by the tendon of the Peroneus longus muscle, in the middle a transverse ridge (tuberosity), and behind it an irregular surface, both of which give attachment to the calcaneo-cuboïd ligament; the former also to some fibres of the ligamentum longum Plantæ. In front is a smooth surface, divided into two parts, the internal one being square, the external triangular and articulated, the former with the fourth, the latter with the fifth metatarsal bone; behind, a surface by which it is united with the os calcis; externally is observed a groove, continuous with that on the inferior surface, and serving for the transmission of the tendon of the Peroneus longus muscle. On the internal surface may be observed, towards its middle, an elongated, smooth, and nearly flat portion, which articulates with the third cuneïform bone, the part before and behind it being rough, for the attachment of ligaments. The cuboïd articulates with the fourth and fifth metatarsal bones before, with the os calcis behind, and with the external cuneiform, and sometimes with the naviculare.

Os Naviculare.

55. Not unfrequently called the scaphoïd bone. It presents round its circumference inequalities for the attachment of ligaments; behind, a concavity for the anterior surface of the astragalus; in front, three separate surfaces for articulation with the three cuneïform bones; on the inner side a prominence receiving the attachment of the tibialis posticus muscle; on the outer side in some instances a small articular surface, by which it is united to the os cuboïdeum. It articulates with the three cuneïform bones, with the astragalus, and sometimes with the cuboïd.

The Cuneïform Bones.

56. These constitute the most anterior part of the tar-

sus; the name expresses their form. In number three, they are distinguished by their numerical order from within outwards. The first is the largest, the second, or middle, the smallest. They articulate behind with the navicular, and in front with the first, second, and third metatarsal bones. In consequence of their excess in length over the second, the first and third, in addition to articulating laterally with the corresponding sides of that bone, are in apposition with the base of the second metatarsal bone, which is inserted between them. The inner side of the first is subcutaneous, and the outer side of the third is in relation, by two separate surfaces, with the cuboïd and fourth metatarsal bones.

Attachments of Muscles. The os calcis, by its superior surface, to the extensor brevis digitorum pedis; the posterior surface to the common tendon of the gastrocnemius and soleus (*tendo Achillis*), and to that of the plantaris; the inferior surface, on the inner side, to the flexor accessorius, and part of the adductor pollicis; on the outer side to the abductor digiti minimi; and in front to part of the flexor brevis pollicis; behind to the flexor brevis digitorum.

Os cuboïdeum, by the inferior surface, to a portion of the abductor pollicis.

Os naviculare, by its tuberosity, to a portion of the tendon of the tibialis posticus.

Ossa cuneïformia. The first, by its base, to portions of the tendons of the tibialis anticus and posticus, and the second and third to part of the flexor brevis pollicis.

The Metatarsus.

57. The second, or middle portion of the foot, is analogous to the corresponding portion of the hand (metacarpus), and like it is composed of five bones placed parallel one with the other. They are named according to their numerical order, from within outwards. The first, or that supporting the great toe, is the shortest, with the exception of

the last, but it exceeds all the others very considerably in thickness. The second is the longest, and the rest decrease successively in length. In all, the thickness of the extremities, particularly of the tarsal ends, is greater than that of the bodies. Though the form of the bodies is very irregular, they may, like the metacarpal bones, be considered as presenting a dorsal, a plantar, and two lateral surfaces. The dorsal surface of all is covered by the tendons of the extensor muscles, the extensor brevis digitorum, and the vessels and nerves; that of the first is broad, inclined inwards, and bounded externally by a prominent line; in the last it looks outwards, and is bounded on the inner side by a like line. In the others are observed analogous lines, placed in the middle, and separating the attachments of the interossei muscles. The plantar surface corresponds to the deep-seated muscles of the foot, and to ligaments serving to connect those bones. That of the first is broader than any of the others. The lateral surfaces form the interosseous spaces, and give attachment to the interosseous muscles. The tarsal extremity presents, in the first, an oval concave surface, broader above than below, articulating with the first cuneïform bone, and inferiorly a tuberosity for the attachment of the peroneus longus; that of the second metatarsal bone, triangular in its form, is, in consequence of the shortness of the corresponding cuneïform bone, impacted between the two other bones of that name, gives attachment to ligaments, articulates behind with the second cuneïform bone, on the inner side with the first metatarsal bone, and on the outer with the second. The tarsal end of the third, also triangular and smaller than the preceding, receives the insertion of ligaments on its upper and under surfaces, and articulates posteriorly with the third cuneïform bone, on the inner side with the second metatarsal bone, on the outer with the fourth. The extremity of the fourth metatarsal bone, cubical in its form, is connected by ligaments to the adjacent bones, and articulates with the cuboïd posteriorly, on the inner side with the third metatarsal and third cuneïform bones, on the outer with the fifth metatarsal. The *posterior* extremity of the fifth metatarsal bone, pyramidal in its form, articulates posteriorly with the cuboïd, and on the inner side with the fourth metatarsal bone; on its external and lower side is a rough tuberosity, which gives attachment to the peroneus brevis and to part of the abductor minimi digiti.

The anterior extremities of the metatarsal bones are convex, and rounded into the form of a head, flattened at the sides, and elongated from above downwards. The head is bounded by a groove, or neck, better marked on the upper than on the under surface. These extremities are received into shallow depressions in the first phalanges with which they are articulated.

The Phalanges of the Toes.

58. The toes which form the last part of the foot are composed each of three phalanges, except the first, which has but two. The body of the *first* presents three surfaces, one inferior, or plantar, is flat; the others, lateral, are smooth and convex, and meet on the dorsum in a rounded border; they are contracted towards the middle, somewhat rough and broad at the extremities for the attachment of ligaments; concave towards the sole of the foot, and convex superiorly. The posterior extremities, broader than the anterior, are concave, and receive the heads of the metatarsal bones. The anterior terminate in two rounded heads, with an intervening pulley-like surface, the lateral parts being received into depressions, in the contiguous extremities of the second phalanges, whilst the middle groove lodges a prominent line marked on the latter.

The bones of the *second phalanx*, much smaller than the first, are somewhat hollowed on the lower surface, and convex on the upper one; their borders are flat and compressed. The posterior extremities are terminated by two small concave articular surfaces separated by a prominent line, by which means they are adapted to the inequalities observed on the contiguous extremities of the first phalanges. The surfaces of the anterior extremities are nearly similar; they articulate with the third phalanges.

The third set are somewhat conical in their figure, the posterior extremities, or base, being hollow, for their articulations with the ends of the second phalanges, whilst the anterior is rough and scabrous.

Attachments of Muscles. 1. To the tarsal bones. The *os calcis* gives insertion by the tendo Achillis to the gastrocnemius, the soleus, and to the plantaris; and origin to the flexor brevis digitorum, flexor accessorius, to part of the abductor pollicis, flexor brevis pollicis, and abductor minimi digiti; and by its superior surface to part of the extensor brevis digitorum: the *os naviculare* gives insertion to part of the tibialis posticus; the *os cuboïdes* to part of the adductor pollicis: the *first cuneïform* bone to the short head of the flexor brevis pollicis, to part of the tibialis anticus and posticus; the *third* to part of the flexor brevis pollicis.

2. To the metatarsal bones. The *first* gives attachment to the prolonged tendon of the peroneus longus, to the transversalis pedis, and the first dorsal interosseous: the *second* to two interossei: the *third* to part of the adductor pollicis, to three interossei, and part of the transversalis pedis: the *fourth* to three interossei also: the *fifth* to the peroneus brevis and tertius, the transversalis pedis, part of the flexor brevis, minimi digiti, and to the fourth dorsal interosseous.

3. To the bones of the toes. The *first* phalanx of the great toe gives insertion to the abductor, flexor brevis, and adductor pollicis, and to the transversalis pedis: the *second* phalanx to the extensor proprius pollicis and flexor pollicis longus: the *second* phalanges of the other toes receive the insertion of the tendons of the flexor sublimis; and the *third* those of the flexor profundus.

Ossa Sesamoïdea.

These do not properly form part of the skeleton; they may be considered as accessories to the tendons of muscles, and are found only in the limbs, never in the trunk. In the superior extremity two are always found in the articulation of the metacarpal bone of the thumb with its first phalanx, and sometimes in the corresponding joint of the fore-finger. In the lower extremity, two are situated behind the femoral condyles, also behind the first joint of the great toe, and sometimes of the others; as well as in the tendons of the tibialis posticus and peroneus longus. They are situated in the direction of flexion, (the only exception being the patella, which belongs to this class of bones) and serve the purpose of increasing the power of muscles, by altering their line of direction, and removing them farther from the axis of the bone on which they are intended to act.

The Bones of the Superior Extremity.

The upper extremity consists of the shoulder, the arm, the fore-arm, and hand. The shoulder consists of the scapula and clavicle, the arm of the humerus, the fore-arm of the radius and ulna, and the hand of the carpus, metacarpus, and fingers.

The Scapula.

59. This bone is placed upon the upper and back part of the thorax, occupies the space from the second to the seventh rib, and forms the posterior part of the shoulder.

Its *form* is irregularly triangular and flat. It presents for examination two surfaces, three borders, and three angles.

The anterior surface, called also *fossa subscapularis*, looks towards the ribs, is triangular, slightly concave, intersected by prominent lines, directed from within outwards and upwards, and therefore crossing the direction of the ribs.

The posterior surface (*dorsum scapulæ*) is divided into two parts, but unequally, by a prominent ridge, (*the spine*); of these the superior one is called *fossa supra-spinata*, the inferior, *fossa infra-spinata*. The spine is a triangular eminence, flattened from above downwards, commencing, at the posterior border of the scapula, with a smooth flat surface, from which it becomes gradually more elevated as it proceeds forwards, until it terminates in an elongated process (*acromion*) which surmounts the shoulder joint. Its superior surface is concave, and conjointly with the superior part of the dorsum of the scapula, forms the fossa supra-spinata. The inferior surface is irregularly triangular, constitutes part of the infra spinous fossa, and in its middle may be observed a small foramen for a nutritious vessel. On the external border, which is rough and broad, may be observed two margins, of which the superior one gives attachment to the trapezius, the inferior to the deltoïd muscle. The internal border, or base, rests on the dorsum of the bone; the anterior one, round and somewhat concave, approaches the neck of the bone, and is continuous with the under surface of the *acromion*. This is a considerable eminence, flattened in the direction opposite to that of the spine. Its posterior and upper surface, convex and irregular, is subcutaneous; the anterior and inferior one, concave and smooth, is in relation with the supra-spinatus muscle, and looks towards the shoulder joint; the superior border presents, anteriorly, a small oval surface for its articulation with the external extremity of the clavicle, and its summit affords attachment to the coraco-acromion ligament. The posterior extremity of the spine is depressed and triangular, the base of the triangle constituting part of the posterior border, or base of the scapula. The *fossa supra-spinata* is wider posteriorly than anteriorly. The *fossa infra-spinata* much larger than the preceding, is convex in the middle, somewhat concave, or rather grooved, inferiorly. Between the latter part and the axillary border is a slightly raised and elongated surface, extending from the inferior angle to the glenoïd cavity. This is divided into two parts, by an oblique linear impression; the posterior division, flat and nearly quadrilateral, giving origin to the teres major; the anterior to the teres minor; whilst the line of division between them marks the attachment of an aponeurosis, common to these muscles, and to the infra-spinatus.

Of the three *borders* the superior is the shortest; at its fore part is situated a notch, which is converted into a foramen by a ligament, and is traversed by, sometimes, the supra-scapular vessels and nerve, but, usually, by the nerve alone. In front of this opening it is surmounted by the *coracoïd* process, which is an elongated eminence, curved on itself. This process, superiorly convex and unequal, gives attachment to the coraco-clavicular ligament; anteriorly to the pectoralis minor muscle; posteriorly to the coraco-acromion ligament; and by its extremity to the biceps and coraco-brachialis muscles. The posterior, or vertebral border, named also the base of the scapula, superiorly approaches to the vertebral column; inferiorly it is more considerably removed from it. It is slightly rounded; and, for the purpose of more easily assigning the attachment of the several muscles which are connected with it, we may regard it as divisible into two margins, with an interspace.

The postero-superior angle is formed by the junction of the base and superior costa of the scapula; it is somewhat inclined outwards. The inferior angle is placed at the union of the base with the axillary, or inferior border of the bone; upon it may be observed an elongated flat surface, which gives origin to the teres major, and over which slides the latissimus dorsi muscle. At the convergence of the superior and inferior borders may be observed a narrow part, denominated the *neck*, which gives attachment to the fibrous capsule of the shoulder joint, and is surmounted by the articular surface of the bone called the *glenoïd* cavity. This is a shallow, oval depression, broader below than above, covered with cartilage in the fresh state, and deepened somewhat by a fibro-cartilaginous margin, which passes round it from the tendon of the biceps muscle, whose origin is at its upper margin; its greatest diameter is perpendicular, its direction outwards and forwards. In this last respect, however, it varies considerably, for during the more extended motions of the humerus, the scapula is made to turn, as it were, on a pivot driven through the centre of its dorsum, by which means the glenoïd cavity is kept constantly in apposition with the head of the humerus, which is the chief security against its dislocation. The scapula affords attachment to the following muscles:

The subscapular fossa (the anterior or costal surface of the bone) to the subscapularis muscle. Posterior or dorsal surface; the spine, (by its external border and the acromion) superiorly to the trapezius, inferiorly to the deltoid. The fossa supra-spinata, by its posterior two-thirds, to the muscle of the same name. The fossa infra-spinata, by a slight oblique line situated near the inferior angle, to the aponeurosis common to the infra-spinatus, teres minor, and teres major; by a narrow surface, near the axillary border, to the teres minor; by the flat surface, at its inferior angle, to the teres major; in the rest of its extent, to the infra-spinatus.

The superior border to the omo-hyoideus; the coracoid process, anteriorly, to the pectoralis minor, by its summit, to the biceps and coraco-brachialis. The posterior border or base, anteriorly, to the serratus magnus; posteriorly, to the supra-spinatus and infra-spinatus; in the interspace to the rhomboidei. The inferior, or axillary border, superiorly, by a depression to the long portion of the triceps extensor; posteriorly, by an unequal surface, to some fibres of the teres minor; inferiorly, to the teres major.

The supero-posterior angle to the levator anguli scapulæ; inferior angle to the teres major, and some fibres of the latissimus dorsi; anterior angle, (glenoid cavity,) by its upper margin, to the long head of the biceps muscle.

The Clavicle.

The clavicle is extended, transversely, between the acromion process of the scapula and the summit of the sternum, which it serves to connect; its direction, however, is not exactly horizontal, the acromial end being slightly elevated. Elongated, and irregular in its form, this bone is curved somewhat like an italic *f*, the degree of the curvature being less in young and female subjects than in male adults; it is prismatic and triangular towards the sternal, broad and flat towards the scapular extremity, and divided into a body and two extremities. The superior surface of the body is principally subcutaneous; the inferior surface presents, near the sternal extremity, inequalities for the attachment of the costo-clavicular ligament; in the centre, a longitudinal depression, in which is observed the foramen for the entrance of the medullary vessels, and, more externally, a rough oblique line, to which the coraco-clavicular ligaments are attached; its anterior border is broad and convex towards the sternal, thin and concave towards the scapular extremity; the posterior border presents, of course, the opposite arrangement of curvatures. The internal extremity is inclined downwards and forwards; it is considerably thicker than the other parts of the bone, and terminates in a triangular unequal surface, which is convex from above downwards, concave from behind forwards; this is tipped with cartilage, and articulates with the sternum; its entire circumference gives attachment to ligaments. The scapular extremity is inclined backwards and upwards, and articulates with the acromion by a narrow surface which is covered with cartilage.

Attachments of Muscles. The clavicle gives attachment, by the superior surface of its sternal extremity, to the sterno-cleido-mastoid; the longitudinal depression, on its inferior surface, to the subclavius; the anterior border, by its sternal half, to the pectoralis major, by its acromial third to the deltoid; the posterior border, by its acromial third, to the trapezius.

The Humerus.

60. This bone, placed between the scapula and fore-arm, is long and irregularly cylindrical in its form, and divisible into a body and two extremities. The *body*, thick and rounded superiorly, is somewhat expanded, and triangular inferiorly. It is divided into two nearly equal surfaces by two longitudinal lines, of which one is external and anterior, the other internal and posterior. These lines may be considered as arising, the former from the external, the latter from the internal condyle, near to which they are well marked, but gradually subside as they proceed upwards on the body of the bone; they afford attachment to the inter-muscular aponeuroses. The external one is interrupted about the middle by a slight depression, or groove, marking the course of the musculo-spiral nerve and superior profunda artery; the surfaces thus separated are named posterior and anterior. The *posterior* surface is round superiorly, and inclined a little inwards; in the lower part it is broad, flat, and turned outwards; it is covered in the entire of its extent by the triceps extensor muscle, and towards its middle may be observed a small foramen for the medullary vessels. The *anterior* surface is divided into two unequal portions by a longitudinal groove, directed obliquely downwards and inwards, for about one-fourth of the length of the bone; this lodges the long tendon of the biceps muscle, and is therefore named the *bicipital* groove; its anterior margin gives attachment to the pectoralis major, the posterior to the latissimus dorsi and teres major. The part of the anterior surface which is internal to this groove, is smooth in the greater part of its extent, and presents, towards its middle, a linear elevation for the insertion of the coraco-brachialis, and lower down an oblique medullary foramen; but on the external part of the same surface, may be observed a broad rough eminence for the insertion of

the deltoïd muscle, beneath which runs the oblique depression already noticed, as giving transmission to the musculo-spiral nerve and the accompanying artery.

At the *superior extremity* of the bone may be observed a large hemispherical eminence, covered with cartilage in the fresh state, and directed backwards and inwards to the glenoïd cavity of the scapula, with which it articulates; this is called the head of the humerus. It is supported by a slightly depressed part, better marked superiorly than in the opposite direction, and denominated the neck of the bone. Somewhat externally to the head are two smaller eminences, which, from their relative size, are named the greater and lesser tuberosities; the former, external and posterior in its situation, convex in its outline, and marked on its upper border by three flat surfaces for the insertion of the external rotator muscles. The other tuberosity, smaller but more prominent, gives attachment to the subscapularis muscle. They are separated by the bicipital groove. The *inferior extremity* is flattened and somewhat twisted from behind forward, its greatest diameter is transverse; it presents internally a considerable projection, the *inner condyle*, which is inclined backwards, and gives attachment to the internal lateral ligament of the elbow joint, and to a tendon common to the greater number of the anterior muscles of the foramen. Externally is situated another smaller process (*the external condyle*) to which are attached the external lateral ligament, and a tendon common to the muscles of the posterior and external surfaces of the fore-arm. Between the condyles is placed the inferior articular surface, which is inclined somewhat forwards. Proceeding in the enumeration of the parts which enter into its composition from the radial to the ulnar side, we observe a rounded eminence placed rather on the anterior surface of the bone, and articulating with a cavity observable on the superior extremity of the radius, a slight groove or depression corresponding with the circumference of this eminence, a semicircular ridge, which is lodged in the space intervening between the radius and ulna; a wide and deep groove which receives the prominent part of the larger sigmoïd cavity of the ulna, and lastly, a prominent ridge, which is received into the internal part of the same cavity. This prominence descends much lower than the external portion of the articular surface, and determines an obliquity in the direction of the humerus, when its lower extremity is made to rest on a plane surface. The groove with its margins, forms a well marked pulley-like surface, on which the sigmoïd cavity of the ulna moves in flexion and extension, hence it is termed the *trochlea*. At the fore-part of the inferior extremity of the bone, and immediately above the trochlea, is a superficial depression which receives the coronoïd process of the ulna during flexion, and posteriorly a more considerable fossa, which lodges the olecranon during the extension of the fore-arm.

A modification of the nomenclature applied to these different eminences has been proposed by Chaussier; retaining the term trochlea for the surface of articulation with the ulna, he calls that which articulates with the radius, the condyle, and for the two lateral eminences of insertion, now named condyles, he substitutes the terms *epi-trochlea* and *epi-condyle*.

Attachments of Muscles. The posterior surface to the triceps; the anterior (by the posterior margin of the bicipital groove,) to the teres major and latissimus dorsi; in the middle, by a slightly marked line to the coraco-brachialis; inferiorly, to the brachialis anticus; the external portion of the same surface, superiorly, by a rough eminence to the deltoïd, by the anterior margin of the bicipital groove, to the pectoralis major. The greater tuberosity gives attachment by the three flat surfaces on its upper border, to the supra-spinatus, infra-spinatus, and teres minor muscles; the lesser tuberosity to the subscapularis. The inferior extremity, by its external condyle, to the extensor carpi radialis longior and brevior, extensor communis digitorum, extensor carpi ulnaris, anconeus and supinator radii brevis; by the internal condyle to a tendon common to the pronator radii teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris, and flexor digitorum sublimis.

The Radius.

61. The radius, shorter than the ulna by the length of the olecranon, is placed at the external side of the fore-arm, extending from the humerus to the carpus. It is broader below than above, slightly arched in its form, and divided into a body and two extremities. As the body is somewhat triangular, we observe on it three surfaces, bounded by three margins, or angles. The *anterior* surface expands towards the lower part, is marked at the centre by a longitudinal depression for the flexor pollicis longus; superiorly is situated the foramen for the medullary vessels, its direction being from below upwards; and inferiorly a flat surface, corresponding with the pronator quadratus. The *posterior* surface, convex in the greater part of its extent, is grooved at its central third, for the origin of the extensors of the thumb; the *external* surface, round and convex, is marked towards its middle by a rough impression that gives insertion to the pronator radii teres. Of the margins separating these surfaces, the posterior is distinct only at the middle part; the external is round, and becomes smooth towards the lower extremity, whilst the internal is acute and sharp for the attachment of the interosseous ligament. The body is terminated superiorly by a rough prominence, termed the *bicipital tuberosity*, from its giving insertion to the biceps muscle.

Above the tuberosity the bone becomes narrowed and constricted into the form of a *neck*, which is again surmounted by the *head*, intended by its extremity to articulate with the round convex part of the lower extremity of the humerus—*tuberosity* (*condyle*, Chauss.) whilst its margin rolls on the lesser sigmoïd cavity of the ulna; the latter is smooth and convex; the former, also smooth, is a shallow cup-like cavity.

The inferior extremity of the radius, much larger than the superior, is nearly quadrilateral in its form; anteriorly it gives attachment by a prominent ridge to the anterior ligament of the wrist joint; posteriorly may be observed grooves which transmit the tendons of the extensor muscles; of these, one narrow and oblique in its direction, and nearly in the middle line, lodges the tendon of the extensor pollicis (secundi internodii). Another at the ulnar side of this, much broader, transmits the tendons of the extensor communis and indicator, whilst a third to its radial side, and divided into two parts by a linear impression, marks the passage of the flexor carpi radialis, longior and brevior. Corresponding with the external border of the bone, is another groove, directed obliquely forwards and divided into two parts, for the tendons of the extensores primi internodii, and ossis metacarpi pollicis. The border by which the two latter grooves are separated, is prolonged downwards, and named the *styloid process;* it affords attachment to the external lateral ligament of the wrist joint. On the inner side of the bone is situated a small oval cavity, covered by cartilage, which articulates with the inferior extremity of the ulna. Inferiorly, the radius terminates in an articular surface, divided from before backwards, by a line, into two unequal portions, of which the external triangular articulates with the os scaphoïdes, the internal is square, and articulates with the os lunare.

Attachments of Muscles. The anterior surface, by its superior three-fourths, to the flexor longus pollicis; by the oblique line, leading from the tuberosity to the insertion of the pronator radii teres, to the supinator brevis and flexor sublimis; its inferior fourth to the pronator quadratus; the posterior surface, by a slight concavity in the middle, to the extensores pollicis; the external margin, by a rough surface, to the pronator teres; inferiorly, to the pronator quadratus and the supinator radii longus; whilst the posterior part of the bicipital tuberosity gives attachment to the biceps muscle.

The Ulna.

62. Placed at the inner side of the fore-arm, the ulna is a long, rather irregular bone, larger at the upper than at the lower extremity. Its body, or middle part, is marked off into three surfaces, by three prominent lines. These are all broader above than below, in consequence of the decreasing size of the bone. The *anterior* surface, slightly depressed, is grooved longitudinally for the origin of the flexor profundus, and marked at its upper third by a foramen directed obliquely upwards for the medullary vessels. The *internal* surface, smooth and somewhat excavated superiorly, becomes round inferiorly, where it is subcutaneous. The *external* surface, rough and irregular, is divided into two parts, of which one corresponds with the superior extremity of the bone, and forms an elongated depression for the anconeus muscle; the other, reaching to the lower extremity, gives origin to the extensors of the thumb and supinator radii brevis. Of the three margins, the anterior and posterior are round, and for the most part smooth, the external is sharp, and gives attachment to the interosseous ligament.

At the superior extremity are situated two eminences, so placed as to bound the articular cavity. Of these, one called *olecranon* (ολενη, *ulna;* κρανιον, *the head*) is nearly on a line with the shaft of the bone; the other, the *coronoid process* (κορωνη, *a crow's beak;* εἶδος, *like*), projects from its anterior surface. The olecranon terminates in a rough tuberosity and an obtuse point, the former giving insertion to the triceps extensor, the latter being lodged, when the arm is extended, in the posterior cavity at the end of the humerus. Anteriorly, this process is concave and smooth; posteriorly, is a flat triangular surface, which is subcutaneous.

The coronoïd process, prominent and pointed, is received during flexion into the anterior depression on the humerus; its anterior surface, rough and triangular, gives insertion to the brachialis anticus; the superior is smooth and excavated; its inner border gives attachment to the internal lateral ligament, the external is hollowed into a smooth depression, the *smaller sigmoïd cavity*, which articulates with the head of the radius. The *great sigmoïd cavity*, formed by the junction of the smooth surfaces of these two processes, has been so named from some supposed resemblance to the Greek letter Σ (*σιγμα*, *εἰδος*, *like*); but if viewed in profile, it much more nearly resembles the letter C. Covered by cartilage in its entire extent, it is divided into two parts by a middle angular ridge, the half cavities on each side of which are again subdivided by a transverse line, ending at each margin in a small notch. At the inferior extremity, which is very small, are situated two eminences, of which the external one, named the *head* of the ulna, round and covered with cartilage, corresponds inferiorly with the triangular fibro-cartilage of the wrist joint, and externally is received into a cavity on the contiguous border of the radius. The internal eminence, named the *styloid process*, on a line with the posterior surface of the bone, and elongated in its form, gives attachment to the internal lateral ligament of the joint. These processes are separated posteriorly by a groove, which is traversed by the tendon of the extensor carpi ulnaris, and inferiorly by a depression into which the triangular fibro-cartilage is inserted.

Attachments of Muscles. The anterior surface, superiorly, and in the middle, gives attachment to the flexor digitorum profundus; inferiorly, to the pronator quadratus: the posterior surface, to the anconeus, the extensor carpi ulnaris, supinator radii brevis, the extensores pollicis, and the extensor indicis; by the posterior longitudinal line, to an aponeurosis common to the flexor carpi ulnaris, flexor digitorum profundus, and extensor carpi ulnaris. The superior extremity, by the summit of the olecranon to the triceps brachialis; the coronoïd process, by a rough surface to the brachialis anticus; by its internal side, to the second origin of the pronator teres.

The Hand.

The hand is composed of the carpus, metacarpus, and fingers.

The Carpus.

63. The first, or superior part of the hand, is so named; it is placed between the fore-arm and the metacarpus, and composed of eight small bones, which are disposed in two ranges, each consisting of an equal number. Proceeding in the enumeration from the radial to the ulnar side, the bones which constitute the first, or superior range, are the scaphoïdes, semi-lunare, cuneïforme, and pisiforme; those of the second, or inferior range, are the trapezium, trapezoïdes, os magnum, and unciforme. The dorsal surface of the carpus is convex, the palmar concave and irregular, and marked by four bony prominences, across which is stretched the annular ligament, so as to form a canal for the transmission of the flexor tendons.

Os Scaphoïdes.

64. Its form is convex on one side, concave on the other. It articulates superiorly with the inferior articular surface of the radius; inferiorly, with the trapezium and trapezoïdes; on its ulnar side by two small surfaces, the superior with the os semi-lunare, the inferior with the os magnum; on its radial side, is attached the external lateral ligament of the wrist joint; posteriorly is a groove for the attachment of ligaments.

Os Semi-lunare.

65. Irregularly triangular in its form, convex superiorly,

it articulates with the square part of the articular surface of the radius; inferiorly, concave, with the os magnum and unciforme; on the ulnar side with the os cuneïforme; on the radial side with the os scaphoïdes; anteriorly and posteriorly it gives attachment to ligaments.

Os Cuneïforme.

66. Its form is pyramidal; superiorly, it is in relation with the inter-articular fibro-cartilage of the wrist joint; inferiorly, it articulates with the os unciforme; on the ulnar side, gives attachment to ligaments; on the radial side, articulates with the os semi-lunare; anteriorly it affords attachment to muscles, and presents a small articular surface for the os pisiforme.

Os Pisiforme.

67. Is placed on a plane, anterior to the other bones of the carpus. Its form is indicated by its name. It presents but one articular surface, which is situated on the posterior part, or base, and is in relation with the anterior surface of the os cuneïforme; it affords attachment, anteriorly, to the annular ligament of the carpus.

Os Trapezium.

68. Superiorly concave, it articulates with the os scaphoïdes; inferiorly, concave from behind forward, and convex transversely, with the first metacarpal bone; on the ulnar side, with the os trapezoïdes, and, by a small surface situated more inferiorly, with the second metacarpal bone; on the radial and posterior sides it gives attachment to ligaments; anteriorly it presents a groove, traversed by the tendon of the flexor carpi radialis, and an eminence to which the annular ligament of the carpus is attached.

Os Trapezoïdes.

69. It articulates superiorly with the os scaphoïdes; in-

feriorly, with the second metacarpal bone; on the ulnar side, with the os magnum; on the radial side, with the trapezium; the anterior and posterior surfaces afford attachment to ligaments.

Os Magnum.

70. This is the largest of the carpal bones; its form is oblong, round superiorly, cubic inferiorly; the superior surface, named its head, is supported by a narrowed portion, named the neck; its greatest convexity is in the antero-posterior direction, where it is received into a cavity formed by the scaphoïdes and semilunare; it articulates, inferiorly, by three distinct surfaces, of which the middle is the largest, with the second, third and fourth metacarpal bones; on the ulnar side, with the os unciforme; on the radial side, with the os trapezoïdes; anteriorly and posteriorly it affords attachment to ligaments.

Os Unciforme.

71. Articulates, superiorly, with the os semi-lunare; inferiorly, by two distinct surfaces, with the fourth and fifth metacarpal bones; on the ulnar side, with the os cuneïforme; on the radial side, with the os magnum; anteriorly it presents a slightly crooked process, (whence its name) which affords attachment to the anterior annular ligament of the carpus; posteriorly it gives attachment to ligaments.

The Metacarpus.

72. Forms the second, or middle portion of the hand, being situated between the carpus and phalanges; it is composed of five bones, which are designated in their numerical order, the enumeration being commenced at the radial side. These bones are placed parallel one with the other, and nearly on the same plane, with the exception of the first, which is more anterior than the rest, and alters its relative position to them in its various movements. They vary

in size, the first being thicker and shorter than the others, which gradually diminish in length from the second to the fifth. They are all slightly concave on the palmar surface, convex on the dorsal, larger at their extremities than in the bodies or middle part, terminated, superiorly, by an unequal eminence, inferiorly, by a rounded head.

The form of the bodies is irregular, but may, in each, be regarded as presenting a palmar, a dorsal, and two lateral surfaces. The palmar surface is narrow, and presents, in the middle, a prominent line, which separates the attachments of muscles, and corresponds to the tendons of the flexor muscles; as also in the first, to the opponens and flexor brevis pollicis, and in the third to the adductor pollicis.

The dorsal surface, convex in the first, presents, in the second, third, and fourth, a prominent longitudinal line, which, bifurcating, forms the sides of a triangular surface, extending over two-thirds of their length; in the fifth, also, is observed a prominent longitudinal line, directed, obliquely, from the ulnar to the radial side. The lateral surfaces afford attachment to muscles; broad in the four last bones, these surfaces are narrowed, and form merely borders in the first.

The superior extremity presents, in each, some peculiarities which render a separate description necessary; on the first is observed a surface, which is concave in the antero-posterior, and convex in the opposite direction, which articulates with the trapezium; in the second, a concave surface, articulating with the trapezoïdes; on the radial side, a small surface, which articulates with the trapezium; on the ulnar side, a double surface, united to the os magnum, and the third metacarpal bone; on the third, a nearly plane surface, articulating with the os magnum; on the radial and ulnar sides, surfaces for articulation with the contiguous metacarpal bones; on the fourth, two articular surfaces, connected with the os magnum and unciforme, on the radial side, two surfaces, and, on the ulnar side, one, for articulation with the corresponding surfaces of the bones on each side; on the fifth, a concave surface, directed outwards, corresponding with the os unciforme; and, on the radial side, a surface for the fourth metacarpal bone. The anterior, or digital extremities of all are convex, articulated with the phalanges, the smooth surfaces extending farther on the palmar than on the dorsal aspect of the bones.

The Bones of the Fingers.

73. These are fourteen in number, each, with the exception of the thumb, having three separate pieces, (*phalanges, internodia*). Of these the first is longer than the second, and the second than the third. Like other long bones, each is divided into a body, a base, and a head. Winslow, and some other anatomists, reckon three phalanges in the thumb, as they conceive that its posterior, or most moveable bone, resembles the first phalanges of the fingers, rather than the metacarpal bones. But if its conformation be examined with attention, more especially that of its anterior extremity, and also its mode of articulation with the bone in front of it, its analogy with the metacarpal range will appear more striking than with the first digital phalanges; and so it is considered by Meckel, Portal, Hip. and J. Cloquet. The bodies of the first phalanx are convex on the dorsal surface; flat, from side to side, on the palmar, but arched from before backwards; the latter is bounded by two sharp margins, which give insertion to the fibrous sheaths of the flexor tendons. The larger, or *posterior* extremities present an oval smooth surface, whose greatest diameter is from side to side, intended to receive the convex heads of the corresponding metacarpal bones. The *anterior* extremities, smaller than the other, end in two small lateral condyles, with a slight groove between them, both being adapted to the base of the contiguous bones, so as to form ginglimus, or hinge-joints. The articular sur-

face is prolonged farther on the palmar than on the dorsal aspect, which allows a more free range to the motion of flexion.

The second row consists of four bones, the thumb having only two pieces corresponding with those of the first and last phalanx. Smaller than the preceding set, they still resemble them in their general outline. The broader, or *posterior* extremity, ends in an articular surface, divided by a slight ridge, extending from before backwards, the lateral parts being concave, for the reception of the two eminences on the contiguous bone; the *anterior* extremity is divided into two lateral convex surfaces, which are lodged in depressions in the base of the last phalanx.

The third row (*phalanges unguium,* Soemm.) consists of five pieces, that of the thumb being the largest. Their form is that of a truncated pyramid, convex on the dorsal, flat on the palmar, rough at the summit, which corresponds with the points of the fingers, and at the base, for the attachment of ligaments and flexor tendons. The articular surface, at the base, resembles that of the base of the second phalanx, in having two shallow concavities, divided by a central convex line.

Attachments of Muscles.—To the carpal bones. The *pisiforme* gives origin to the abductor minimi digiti, and insertion to the flexor carpi ulnaris: the *trapezium* to the opponens and abductor pollicis: the *trapezoïdes* to part of the flexor brevis pollicis: the *magnum* to part of the same: the *unciforme* to the flexor parvus (minimi digiti) and to the adductor.

2. To the metacarpal bones. The *first,* or that of the thumb, gives insertion to the extensor ossis metacarpi pollicis and to the opponens pollicis, and origin to part of the abductor indicis: the *second,* or that of the fore-finger, to the flexor carpi radialis on its palmar end, and to the extensor carpi radialis longior on the dorsal surface of its base, and by its lateral surfaces to the two first interossei muscles: the *third,* to the extensor carpi radialis brevior, to the adductor pollicis, and

also to two interossei: the *fourth*, to two dorsal interossei and one palmar: the *fifth*, to the extensor carpi ulnaris, and adductor minimi digiti.

3. To the bones of the fingers. Those of the *first* range of the four fingers give attachment by their lateral borders to the tendinous sheaths of the flexor tendons; their dorsal surface is covered by the expansion of the extensor tendons. The bones of the *second* row give insertion at their dorsal surface to the tendons of the extensor communis, with which those of the lumbricales and interossei may be said to be blended; the tendons of the flexor sublimis are inserted into their bases at the palmar surface: the *third* set gives insertion to the tendons of the flexor profundus; the fibres of the extensor are also continued on their dorsal aspect.

The *first* phalanx of the thumb gives insertion to the extensor primi internodii, to the flexor brevis, to the adductor and abductor pollicis: the *second* phalanx to the flexor longus, and to the extensor secundi internodii.

Of the Skull.

The skull is of a spheroïdal figure, compressed on the sides; broader behind than before, and supported by its base on the vertebral column. It is divided by anatomists into two parts, the cranium and face, the former being composed of eight bones, viz. the *occipital, two parietal,* the *frontal, two temporal,* the *sphenoïd,* and the *ethmoïd;* the latter is made up of fourteen bones, viz. two *superior maxillary,* two *malar,* two *ossa nasi,* two *ossa palati,* two *ossa unguis,* two *inferior turbinated* bones, the *vomer,* and *inferior maxilla;* the fourteenth is the frontal bone, which is common to the cranium and face. The three bones of the ear are not included in this enumeration, as they belong rather to a special organ than to the skeleton, considered as the frame-work of the body.

The Occipital Bone.

74. *Situated* at the posterior part of the base of the

skull; broad behind, narrowed to a point before, of a trapezoïd figure, presenting two surfaces, four borders, and four angles. *External surface.*—Convex, presenting towards its centre a rough prominence, the *occipital protuberance*, the part between which and the superior angle is smooth. Extending obliquely outwards from the protuberance is a rough line, called the *superior occipital ridge*, to distinguish it from another which is between it and the great foramen, called the inferior occipital ridge; both are prominent, and give attachment to muscles, as also do the rough depressions between them. These are divided by a vertical line extending from the foramen to the protuberance. The occipital foramen *(foramen magnum)* of an oval figure, gives transmission to the medulla spinalis, the vertebral arteries, and sub-occipital nerves. At each side, but nearer its anterior part, are situated the *condyles*, two smooth oblong eminences, which articulate with the first vertebra; behind the condyles are usually found two foramina, which transmit each a vein and small artery, and before them are also two foramina, through which pass the lingual nerves. External to each condyle is a rough surface, for the insertion of the rectus lateralis muscle.

The *internal surface* is marked by two lines, which intersect towards the central point, and mark off four fossæ for the reception of the posterior lobes of the brain and lateral lobes of the cerebellum; the superior and two transverse lines are generally grooved, and correspond with the course of the longitudinal and lateral sinuses. The anterior border of the foramen magnum is slightly excavated, and becomes continuous with the basilar groove on which rests the medulla oblongata; within its margin are the condyloïd foramina, and external to it are two fossæ, marking the terminations of the lateral sinuses. The thick triangular process which projects into the base of the skull from the foramen, is called the *basilar* process; its margins are rough and contiguous to the pars petrosa; its under surface presents slight depressions for the insertion of muscles, and the upper one a shallow groove. The *superior borders* of the bone are dentated, and converge to a point; the inferior are divided into two parts by a prominent piece of bone, the *jugal eminence*, which surmounts an excavation contributing with the temporal bone to form the jugular fossa.

The occipital *articulates* with six bones, viz. with the two parietal by its superior borders—the two temporal by the inferior—with the sphenoïd by its basilar process, and with the atlas by the condyles.

Attachments of Muscles.—The posterior third of the superior curved line gives attachment to the trapezius; its anterior two thirds to the occipito-frontalis above, and to the sterno-mastoid below: the inner part of the space between the ridges, to the complexus: the external part to the splenius capitis: the space between the lower ridge and the great foramen, to the recti majores and minores, and more outwardly to the obliquus superior: the base of the jugal eminences to the recti laterales: the fossæ at the inferior surface of the basilar process, to the recti antici majores and minores; and still more anteriorly to the superior constrictor of the pharynx.

The Parietal Bones.

75. The parietal bones form the roof of the skull; they are convex externally, concave internally, and present two surfaces and four borders. The external surface rises towards its middle, where it presents the parietal prominence, below which is an oblique line, bounding a flat surface, which forms a part of the temporal fossa. The internal surface is marked by branching lines corresponding with the course of the middle meningeal artery, by depressions for the convolutions of the brain, and along the superior border is a slight groove, corresponding with the longitudinal sinus. The superior border is straight, and articulated with its fellow by a series of dentations; the inferior, concave, and

levelled off at its margin, is overlapped by the squamous portion of the temporal bone: the anterior unites with the frontal bone, and the posterior with the occipital. The anterior inferior angle dips down to the sphenoïd, and is marked internally by the meningeal artery: the posterior inferior angle articulates with the mastoïd part of the temporal bone, and presents internally a part of the groove which lodges the lateral sinus.

It gives attachment to the temporal muscle by that part of its surface which lies beneath the temporal ridge.

The Frontal Bone.

76. *Situated* at the anterior part of the skull, and superior part of the face, this bone is divisible into two parts (frontal and orbitar) differing in size and position; of these one is turned upwards and forwards, forms three fourths of its extent, the other inferior, and horizontal in its direction, forms the roof of the orbits. The external surface of the frontal part presents on each side a slight elevation, named *frontal eminence:* beneath this an arched depression, bounded below by the superciliary ridge, which surmounts the margin of the orbit, and towards the inner third of the latter is a small foramen, or sometimes a notch covered in by a ligament, which transmits the frontal nerve and artery. Between the superciliary arches is the nasal eminence, or glabella, which is prominent in proportion to the size of the frontal sinuses, and bounded inferiorly by a rough surface, articulating with the nasal bones, and the ascending processes of the superior maxilla. From this surface projects the *nasal spine,* to articulate in front with the nasal bones, and behind with the perpendicular lamella of the ethmoïd. The internal surface of the bone is concave, and presents along the median line a groove, corresponding with the longitudinal sinus, and a ridge for the attachment of the falx; this ridge terminates in a minute foramen called *foramen*

cæcum, from its having been supposed to be merely a cul-de-sac, but it is in reality pervious, and lodges a small spur-like process of the dura mater, and transmits a vein, which enters the sinus from the nasal fossæ.

The inferior surface of the orbitar processes is smooth and concave, the superior is convex, and marked by depressions corresponding with the cerebral convolutions. They are separated by a deep excavation, which receives within it the cribriform plate of the ethmoïd bone, and round its margins are several cells which complete the cavities lodged within the lateral parts of the last-named bone. In this margin may also be observed two foramina (*anterior* and *posterior orbitar*) which are common to the frontal and ethmoïd bones, as their contiguous margins contribute to their formation. The anterior one transmits the nasal twig of the ophthalmic nerve, and the anterior ethmoïdal artery; the other the posterior ethmoïdal artery and vein. The orbitar plates are bounded by the angular processes, of which the external is the most prominent. Near the inner one is a slight depression for the cartilaginous pulley of the trochlearis muscle; near the outer a depression for the lodgement of the lachrymal gland—the external side of this process is slightly hollowed, and forms part of the temporal fossa.

The frontal *articulates* with twelve bones, superiorly with the two parietal, laterally and behind with the sphenoïd, inferiorly with the ethmoïd; with the nasal bone by the nasal process, and with the ossa unguis; with the ascending process of the superior maxillary bones, and with the malar bones. The mode of articulation differs in different parts of its circumference. Thus the superior border is found to overlap and rest on the parietal bones, whilst towards the lateral and inferior parts the exterior table of the bone is bevilled off, and is covered in by the parietal. The inferior border, straight and squamous, is in a manner inserted between the margins of the two alæ of the sphenoïd bone, with each of which it articulates. It gives attachment to the temporal and corrugator supercilii muscles.

The Temporal Bone.

77. *Situated* at the lateral and inferior part of the skull. To facilitate its description it may be divided into three parts, adopting the division which obtains in infancy, before the ossification is complete. One is superior, flat, scaly, and named the *squamous* portion; another posterior, rough, and thick, the *mastoïd;* the third internal and intermediate, the *petrous.*

The squamous portion by its external surface forms part of the temporal fossa, and is bounded above by an arched border, below by a horizontal process, called *zigoma.* This at its base presents two roots, one anterior transverse bounds the glenoïd fossa, the other, continued horizontally backwards, also bifurcates, one part turning inwards to the glenoïd fissure, whilst the other gradually subsides, yet marks the separation between the squamous and mastoïd portions of the bone. The glenoïd fossa, inclosed by these roots, is elongated from without inwards, and divided into two parts by a fissure *(fissura Glasseri)* which transmits the chorda tympani nerve, laxator tympani muscle, and gives attachment to the processus gracilis of the malleus. The part before the fissure is smooth, and articulates with the lower jaw, the remainder lodges a process of the parotid gland. The *mastoïd,* or nipple-shaped part, bounded by an angular border, is rough externally, and overhangs a groove for the attachment of the digastricus muscle: internally it is hollowed for the lateral sinus, and pierced by a venous foramen opening into the sinus.

The *petrous* part, forming a triangular pyramid, projecting into the base of the skull forwards and inwards, presents a base, an apex (truncated), three surfaces, and three borders. In the base is situated the meatus auditorius externus, which is directed forwards and inwards, and leads into the tympanum. The apex, rough and irregular, is pierced by the carotid canal; this commences in the inferior surface before the jugular fossa, ascends at first perpendicularly, but soon turns horizontally forwards and inwards to the apex, where it ends. The anterior surface towards the apex is slightly excavated, where it corresponds with the Casserian ganglion of the fifth pair of nerves, is marked by a groove, the *hiatus Fallopii*, leading to the aqueduct of Fallopius, and an eminence indicating the situation of the superior semicircular canal. The aqueduct is an osseous canal lodged in the interior of the bone, and passing in an arched direction outwards and backwards, to the stylo-mastoïd foramen; it transmits the portio dura, and receives, through the hiatus Fallopii, the vidian nerve. In the posterior surface may be observed the *meatus auditorius internus*, and above it a very minute one, the aquæductus vestibuli. On the inferior surface, which is exceedingly irregular, we observe, proceeding from within outwards, a rough surface, giving attachment to the levator palati and tensor tympani muscles, the carotid foramen, the jugular fossa, the vaginal and styloïd processes, (the latter elongated, tapering, and directed downwards and forwards, the former thin and irregular, and placed between the glenoïd fossa and the carotid foramen,) lastly, the stylo-mastoïd foramen. The superior border is grooved for the petrosal sinus; in the anterior is situated the orifice of the Eustachian tube, which leads from the pharynx to the tympanum, and a canal which gives passage to the tensor tympani. The posterior border forms part of the foramen lacerum posterius, which is divided by a bony process into two parts, the anterior being for the transmission of the nervus vagus, the glosso-pharyngeal, and the spinal accessory nerves; the posterior for the jugular vein. Before this bony process is a minute foramen, leading to the cochlea, called *aquæductus cochleæ*. The temporal bone *articulates* with the parietal, malar, inferior maxillary, sphenoïd, and occipital bones.

Attachments of Muscles.—To the zigoma is attached the masseter; to the temporal fossa, the temporalis; to the mastoïd process, the sterno-mastoïd, splenius capitis, and trachelo-mastoideus; to the digastric fossa, the digastricus; to the styloïd process, the stylo-glossus, stylo-hyoïdeus and stylo-pharyngeus; to the apex of the petrous portion, the levator palati and tensor tympani.

The Sphenoïd Bone.

78. The sphenoïd bone is situated towards the centre of the base of the skull, and is articulated with all the bones of the cranium, and several of those of the face. Its form has been likened to that of a bat, and the resemblance is very close, particularly if the ethmoïd remains attached, as often happens. Like other irregular bones, it may be divided into a body and processes, or wings.

The body is divided into six surfaces. The superior, or cranial, presents, first, in the median line, a pointed process, which articulates with the ethmoïd bone; two expanded horizontal processes, called the wings of Ingrassias; their form is triangular, the superior surface supports part of the anterior cerebral lobes, the inferior looks towards the sphenoïdal fissure; the anterior border is rough, and articulates with the orbitar plate of the sphenoïd; the posterior smooth, and corresponds with the fissure of Silvius. Beneath the base of these processes are situated the optic foramina; posteriorly they end in two productions, called the *anterior clinoïd processes*. The superior surface is excavated deeply to receive the pituitary gland. This excavation is called cella Turcica, from some resemblance to a Turkish saddle. Before the pituitary fossa is a slightly depressed portion of the bone, on a level with the optic foramina, on which rests the commissure of the optic nerves. The inferior surface presents a prominent spine, called *rostrum*, and at each side two slight lamellæ (projecting from the base of the pterygoïd processes), which articulate with the vomer. At the anterior surface we observe the openings of the sphenoïdal sinuses lodged in the body of the bone.

The posterior surface of the body is flat, and articulated with the basilar process of the occipital bone, and from its superior margin projects forwards and upward a lamella of bone sometimes slightly bifurcated at its extremity, and called the posterior clinoïd process.

The lateral surfaces are continuous with the alæ, or wings, which branch out from it on each side. Each of these presents three surfaces, looking in different directions: one anterior, smooth, quadrilateral, forms part of the external wall of the orbit; another, superior, elongated, and concave, supports the middle lobe of the brain; the third, external, is divided into two parts by a ridge, of which the superior one forms part of the temporal fossa, the inferior, of the zigomatic. The ala terminates posteriorly by a pointed prolongation, which is curved downwards, called the *spinous process*. Projecting downwards perpendicularly from the line of junction between the body and the alæ are observed the pterygoïd processes. Each of these consists of two lamellæ, united at an angle anteriorly, and diverging behind, so as to form an angular groove. The internal plate, longer and narrower than the external, is prolonged into a slight round process, named, from its crooked form, the *hamular process*, round which plays the tendon of the tensor palati muscle. The external lamella looks outwards and somewhat forwards, bounds the pterygoïd fossa, and gives attachment to the external pterygoïd muscle. At the root of the internal lamella is situated a slight depression *(fossa navicularis)*, which gives attachment to the tensor palati; in the groove between the two plates arises the internal pterygoïd muscle, and into the triangular interstice left at their inferior divergence, is received the pyramidal process of the palate bone.

Each lateral half of the bone presents a fissure, three foramina, and a canal. The fissure *(fissura sphenoïdalis)* triangular and elongated, is placed between the lesser and greater wings, opens into the orbit, and transmits the third, fourth, ophthalmic branch of the fifth and the sixth pairs of nerves; and also the ophthalmic vein. This fissure is separated at its base from the foramen opticum by a thin plate of bone connecting the lesser wing with the body of the sphenoïd bone; to this is attached a small tendon, common to the inferior, internal, and external recti muscles of the eye. Of the foramina, one anterior, internal, round *(foramen rotundum)* transmits the superior maxillary branch of the fifth pair of nerves; the other more external, larger, oval *(foramen ovale)* gives passage to the inferior maxillary branch; and the third, *(foramen spinosum)* the smallest, to the middle meningeal artery. The root, or base, of each pterygoïd process is pierced by a circular foramen *(pterygoïdeum)* extending horizontally from before backwards, slightly expanded before, narrowed behind, and giving passage to the posterior branch from Meckel's ganglion (*vidian, pterygoïd*).

The body of the sphenoïd bone articulates posteriorly with the basilar process of the occipital, anteriorly with the ethmoïd; with the orbitar processes of the frontal by the lesser and greater alæ; with the anterior inferior angles of the parietal, and the squamous portion of the temporal, by the great alæ, and by the spinous process with the angle between the petrous and squamous portions of that bone: with the vomer it articulates by the rostrum; with the malar bone by means of the external border of the orbitar plate, and with the palate bones by the pterygoïd processes.

Attachments of Muscles.—Round the optic foramen on each side are attached the four recti, the obliquus superior, and levator palpebræ muscles: to the external surface of the great ala, the temporal muscle: to the external pterygoïd process the external pterygoïd muscle: to the pterygoïd fossa the internal pterygoïd: to the inferior half of the internal pterygoïd plate, the superior constrictor of the pharynx; and to the fossa navicularis, the levator palati.

The Ethmoïd Bone.

79. The ethmoïd bone, common to the cranium, orbit, and nasal fossæ, is of a cuboïd figure, presents six surfaces, and is divided into two equal lateral parts by a perpendicular lamella, the superior part of which projects into the skull in the form of a cock's comb (*crista galli*), the inferior descends into the nares, forming part of their septum. This lamella may be considered as the fundamental part of the bone to which the two lateral masses are applied.

The crista galli, smooth and triangular, rests by its base on the cribriform lamella, its longest side looks backwards, the shortest forwards: the latter in some cases is prolonged into two small bony masses, separated by a fissure, which completes the foramen cœcum. The crista galli is as it were embraced by the anterior narrow part of the falx cerebri, or rather is inserted between the layers of dura mater uniting to form it.

The nasal lamella descends towards the vomer, with which and the nasal cartilage it articulates inferiorly, with the septum of the sphenoïdal sinuses posteriorly, and with the ossa nasi, and nasal spine of the frontal bone, anteriorly.

At each side of the crista are the horizontal plates (*cribriform*) pierced by a number of foramina, for the transmission of the divisions of the olfactory nerve; but the anterior ones, which are larger, and sometimes fissures, give passage to the nasal branch of the fifth nerve. Beneath the cribriform plate are placed the lateral masses of the bone, divided into a number of cells (*ethmoïdal*), the external surface of each mass forming part of the orbit, is flat and smooth (*os planum*), articulates anteriorly with the os unguis, posteriorly with the sphenoïd and anterior process of the palate bone, superiorly with the orbitar process of the frontal bone, with which it contributes to form the orbitar foramina (anterior and posterior) inferiorly with the maxillary bone.

The internal surface of the os planum forms part of the wall of the nasal fossa, and gives attachment to several thin, delicate bony lamellæ, which project inwards, and form the ethmoïdal cells. The spongy bones arch inwards and downwards, their convex surface being directed towards the septum, the concave outwards and downwards, enclosing spaces (*meatus narium*), of which there are three altogether, two formed by the ethmoidal spongy bones, the third by a separate bone. The first, or most superior, very small, covers in the superior meatus. The second is larger every way, and extends from before downwards and backwards; its superior border projects from the side of the ethmoïdal cells, the inferior is free in the nares; the posterior is narrow and unattached, the anterior is prolonged forwards to a level with the anterior border of the crista galli, and articulates with the cellular border of the frontal bone. The middle meatus, thus enclosed, is curved from before backwards and downwards, expanding as it descends, and hence is sometimes called *infundibulum.*

Along the *superior* and external border of the ethmoïd bone are observed several small cells, which are covered in by similar vacuities in the adjacent border of the frontal bone; on the border of this surface are also observed two smooth grooves completed into foramina by similar grooves in the frontal bone; the anterior one transmits the nasal twig of the ophthalmic nerve, and an accompanying artery, the other the posterior ethmoïdal artery and vein.

The *inferior* aspect of the bone is very irregular and cellular like the rest; it articulates with the border of the maxillary sinus, and with the inferior spongy bone.

The anterior extremity articulates with the os unguis, which completes the anterior cells. The posterior joins with the sphenoïdal cells. The ethmoïd articulates with thirteen bones; with the frontal by the cellular margins of its inter-orbitar fossa; with the nasal bones; with the ossa unguis; the superior maxillary bones; with the sphenoïd, the palate bones, the vomer, and inferior spongy bones.

Muscular attachments, none.

The Superior Maxillary Bone.

80. This bone is very irregular; it presents an external convex surface, corresponding with the anterior and lateral parts of the face; another internal, flat, bounding the nasal fossæ; one superior, smooth, and inclined inwards, forming the floor of the orbit, and surmounted internally by a triangular process, forming the side of the nose; lastly, a surface which projects horizontally inwards, to form the arch of the palate. At the junction of the external and inferior surfaces is a thick, dependent margin, for the lodgement of the teeth; to this, as to a common point of union, all the other parts of the bone may be referred.

The alveolar border, thick, semicircular, convex externally, concave internally, is pierced along its margin by a number of deep pits, (*alveoli*,) into which the teeth are inserted. From this border the external side ascends upwards to the margin of the orbit, presenting some depressions and elevations; but at its fore part it is interrupted and excavated into a hollow, which, with a similar one in the corresponding bone, forms the anterior nares. This excavation is surmounted by the ascending or nasal process, prolonged as far as the frontal bone, with which it articulates. The external surface of this process, slightly grooved, gives attachment to the orbicularis palpebrarum and levator labii superioris alæque nasi. The internal, or nasal surface, somewhat concave, presents a rough line, running from before, backwards, which articulates with the inferior spongy bone; above this is a depression corresponding with the middle meatus, and, towards the summit, a rough surface, which closes in the anterior ethmoïdal cells. The anterior border is rough, for its attachment to the nasal bone. The posterior presents a groove, which is completed into a canal by a similar one in the os unguis, for the lachrymal sac.

The part of the external surface, immediately above the second and third molar teeth, is elevated into a rough eminence, (*malar tuberosity*) for its articulation with the malar bone. Anterior and inferior to this is observed a fossa, (*fossa canina,*) which gives attachment to the levator anguli oris. Between this fossa and the margin of the orbit is the infra-orbitar foramen, which transmits the superior maxillary nerve. Behind the malar tuberosity the surface is slightly excavated, and forms part of the zigomatic fossa: towards the posterior border it is plain, and forms one side of the spheno-maxillary fissure; and, at its junction with the orbitar plate, is situated the opening of the infra-orbitar canal. This surface is pierced by a number of foramina, which transmit the dental nerves; it terminates by a tuberosity, which projects behind the last molar tooth. The inner surface of its posterior border is rough, for its attachment to the tuberosity of the palate bone, and presents also a slight groove, contributing to the formation of the *posterior palatine canal,* which transmits the descending palatine branches from Meckel's ganglion.

From the superior border of the external surface the orbitar plate projects inwards, forming the floor of the orbit; its surface is smooth, being merely interrupted by the groove which leads to the infra-orbitar canal.

The horizontal or palate plate of the bone projects inwards, forming the roof of the mouth, and the floor of the nares. Its nasal surface is concave from side to side, and smooth; externally it is continuous with the body of the bone; internally presents a rough surface, which is articulated with the corresponding bone, and surmounted by a ridge, which completes the septum narium by articulating with the vomer and nasal cartilage; beside it is the foramen, leading into the anterior palatine canal. The inferior surface is rough, and the body of the bone is hollowed into a large cavity, *antrum Highmorianum*, or *maxillare*.

Articulations. With the corresponding bone; with the frontal, by its nasal process; also with the ethmoïd and ossa nasi; with the palate bone, by its tuberosity; with the malar, by the malar protuberance; with the os unguis, the vomer, the inferior spongy bone, and nasal cartilage.

Attachments of Muscles. Proceeding from below upwards; to the border of the alveolar arch, the buccinator; to the canine fossa, the levator anguli oris, and the compressor nasi; to the margin of the orbit part of the levator labii; to the nasal process, the orbicularis palpebrarum, and the common elevator of the lip and ala of the nose; and just within the orbit, the inferior oblique muscle of the eye.

The Malar Bone.

81. The malar bone, common to the face and orbit, forms the most prominent point of the side of the former, and the greater part of the outer border of the latter. Its form is quadrangular. The facial or anterior surface, pierced by some foramina for small vessels, is convex, and gives attachment to the zigomaticus muscle. The posterior bounds the zigomatic fossa, and is rough for its articulation with the maxillary bone. The superior surface, lunated, projects into the orbit, and articulates with the frontal, sphenoïd and superior maxillary bones. The superior border forms the outer margin of the orbit; the inferior is on a line with the zigomatic arch, which it contributes to form; the anterior articulates with the maxillary bone; the posterior, curved, gives attachment to the temporal aponeurosis.

It articulates with the frontal, maxillary, temporal, and sphenoïd bones.

Attachments of Muscles. To the zigomatici, by its anterior surface; to the masseter, by its inferior border; by its anterior angle, to part of the levator labii superioris.

The Nasal Bones.

82. The *nasal bones,* situated beneath the frontal bone, and between the ascending processes of the maxillary, are small, and irregularly quadrilateral, and form what is called the bridge of the nose:—the *anterior surface* of each, concave from above downwards, convex from side to side, presents a minute vascular foramen; the *posterior,* or nasal, is marked by the passage of a branch of the nasal nerve; the *superior* border articulates with the frontal bone; the *inferior* with the nasal cartilage; the external with the ascending process of the maxillary bone; the internal with its fellow of the opposite side, and is supported by the nasal spine of the frontal, and the perpendicular plate of the ethmoïd.

They give attachment to the pyramidalis and compressor nasi.

The Os Unguis.

83. Placed at the inner and anterior part of the orbit, it presents two surfaces and four borders; its external surface, plane in the greater part of its extent, is hollowed anteriorly, by a groove which lodges part of the lachrymal sac; hence this bone is sometimes called the lachrymal bone. Part of the internal surface, which is rough, corresponds with the anterior ethmoïdal cells, the rest with the middle meatus narium. The superior border is articulated with the orbitar process of the frontal bone; the inferior with the superior maxillary bone; and where it dips down, to form the lachrymal groove, it joins the inferior spongy bone; anteriorly, it rests on the nasal processes of the superior maxillary bone, and posteriorly on the os planum of the ethmoïd.

The Palate Bone.

84. The *palate bone,* wedged in between the superior maxillary and sphenoïd bones, is common to the cavity of the mouth, nares, and orbit.

Its form somewhat resembles that of the letter L, one part being horizontal, the other vertical. The former, quadrilateral, articulates anteriorly with the palate plate of the maxillary bone; internally, with its fellow of the opposite side; posteriorly it is concave, presents at the inner angle a pointed process, (the palate spine); externally it unites at right angles with the vertical portion of the bone. The inferior surface, forming part of the roof of the mouth, is unequal, and marked by a transverse ridge, and presents an oval foramen, being the inferior termination of the posterior palatine canal, which transmits the descending palatine nerves and accompanying vessels.

At the junction of the horizontal and vertical portions, is situated a thick, rough tubercle, (*tuberosity*, *pyramidal process*,) projecting downwards and backwards. This is marked by three vertical grooves; the two lateral ones are rough, and receive the inferior borders of the pterygoïd processes, the middle one smooth, corresponds with and completes the groove between the pterygoïd plates.

The vertical portion presents two surfaces; one internal, (*nasal*), is divided into two parts by a transverse ridge, which articulates with the inferior spongy bone; that below the ridge forms part of the inferior meatus, that above of the middle. The external, rough and unequal, is divided by a vertical groove, which is completed into a canal, (posterior-palatine canal) by the maxillary bone. The posterior part of this surface articulates with the inner surface of the maxillary bone; the anterior, thin and scaly, with the side of the antrum; superiorly the vertical portion is bifid, and branches into two processes.

Of these, the anterior and external one presents, at its termination, five surfaces; of which the superior, smooth and triangular, forms part of the floor of the orbit; the anterior rests against the maxillary bone; the posterior is rather a rough border, which overhangs the spheno-palatine foramen; the internal one, rough and cellular, completes the ethmoïdal cells, and the external bounds the zigomatic fossa. The posterior terminal process presents three faces; the superior, concave, looks towards the body of the sphenoïd; the external is grooved, and by being applied to the pterygoïd process, forms the pterygo-palatine canal; the internal one corresponds with the nasal fossæ. At the point of divergence of these two processes may be observed a small excavation, with a smooth border, which, when the bone is *in situ*, forms with the sphenoïd, the spheno-palatine-foramen; it is sometimes completed by a small lamella of the palate bone itself.

Articulations:—with the corresponding palate-bone; with the maxillary, ethmoïd, sphenoïd, vomer, and inferior spongy bone.

Muscular Attachments. By its spine, to the azygos uvulæ; by the central groove on its tuberosity, to a small part of the internal pterygoïd; and, by the transverse ridge on the palate plate, to the aponeurosis of the circumflexus palati.

The Vomer.

85. *The vomer*, so called from its resemblance to a ploughshare, is flat, irregularly quadrilateral, and placed vertically between the nasal fossæ, presenting two surfaces and four borders. The lateral surfaces form part of the inner wall of the nasal fossæ; the superior border, thick and deeply grooved, receives the rostrum of the sphenoïd bone; the margins of the groove expand, and are articulated with two small lamellæ at the roots of the pterygoïd processes. The anterior border, also grooved, presents two portions, into one of which is implanted the descending plate of the ethmoïd, and into the other the nasal cartilage. The *posterior* border, dividing the posterior nares, is thin and unattached; the inferior is received into the fissure formed by the palate plates of the superior maxillary and palate bones.

The Inferior Spongy Bone.

86. The inferior spongy bone, or turbinated bone, so called from some resemblance to the lateral half of an elongated bivalve shell, extends from before backwards, along the side of the nasal fossæ: slightly convoluted, it presents an internal convex surface, projecting into the nasal fossæ; an external concave, which arches over the inferior meatus; the superior border articulates with the ascending process of the maxillary bone before, and with the palate bone behind; in the centre with the os unguis; and, by a hooked process, with the side of the antrum; the inferior border is free, slightly twisted, and dependent.

The Inferior Maxillary Bone.

87. The inferior maxilla, convex in its general outline, and shaped somewhat like a horse-shoe, is situated at the inferior part of the face, and is usually considered as divisible into a middle larger portion—its body, and two branches, or rami. The *body* is placed horizontally; its external surface is convex, and marked at the middle by a vertical line indicating the original division of the bone into two lateral parts, and thence named its symphysis. On each side of the symphysis, and just below the incisor teeth, is a superficial depression (the *incisor fossa*), and, more externally, a foramen, which transmits the terminal branches of the dental nerve and artery. A linear eminence may be observed to extend obliquely upwards and outwards from the symphysis to the anterior border of the ramus; it is named the *external oblique* line, and is intended to give attachment to muscles. The internal surface of the body is concave, and marked at its centre by a depression corresponding with the symphysis; at each side of which are two prominent tubercles placed one above the other, and affording attachment to muscles. Beneath them are two slight depressions for the digastric muscles; and from the lower margin may be

observed an oblique and prominent line (the *mylo-hyoïdean ridge*) leading upwards and outwards to the ramus; above the line is a smooth depression for the sublingual gland, and beneath it, but situated more externally, is another for the submaxillary gland. The superior border is horizontal, and marked by notches, corresponding with the alveoli, or sockets of the teeth. The inferior border, thicker at its anterior than at its posterior part, is slightly everted, so as to project somewhat forwards. The external surface of each *ramus* is flat, and marked by slight inequalities; the internal surface presents at its middle a foramen (the *inferior dental*) leading into a canal contained within the bone, and lodging the dental nerve and vessels. Beneath the foramen a slight groove marks the passage of some vessels and a nerve, the rest of the surface being rough, for the insertion of the pterygoïdeus internus. The anterior border is nearly vertical in its direction, and terminates in a pointed extremity, named the *coronoïd process;* it is grooved at its commencement, for the attachment of the buccinator muscle. The posterior border is also almost vertical in adults, but in children and edentulous subjects it departs considerably from this direction, and approaches that of the base of the bone. This border is surmounted by the articular head of the bone (the *condyle*), which is convex and oblong, its greatest diameter being from without inwards; the direction of its axis is oblique, so that if prolonged, it would meet that of its fellow of the opposite side at the anterior margin of the foramen magnum. The interval between the condyle and coronoïd process deeply excavated, is called the sigmoïd notch, and if viewed when the bones are *in situ*, it will be found to form a complete circle with the arch of the zigoma.

Attachments of Muscles. To the incisor fossa, the levator menti; to the external oblique line, the depressor labii inferioris, depressor anguli oris, and a small part of the platisma myoïdes.

To the upper tubercles on the inner surface of the symphysis, the genio-hyo-glossi; to the inferior ones, the genio-hyoïdei; to the depression beneath these, the digastricus; to the internal oblique line, the mylo-hyoïdeus, and a small part of the superior constrictor of the pharynx posteriorly. To the external surface of the ramus, the masseter; to the lower part of the inner surface, the pterygoïdeus internus; to the neck of the condyle, the pterygoïdeus externus.

The Os Hyoïdes.

88. So called from some resemblance to the Greek letter υ; it is situated at the base of the tongue, and may be felt between the chin and thyroïd cartilage. It consists of a body, two cornua and two cornicula. The anterior surface of the body is convex, and marked at the middle by a vertical line, on each side of which are depressions for the attachment of muscles; its posterior surface is concave, and corresponds with the epiglottis. The cornua project backwards and end in a rounded point. The cornicula, short, and irregularly conical, are placed at the junction of the body with the cornua, and give attachment to the stylo-hyoïdean ligament; they continue for a long time moveable, as the cartilage which connects them remains unossified to an advanced period of life.

Attachments of Muscles and Ligaments. The stylo-hyoïdean ligaments, to the cornicula; the thyro-hoïdean, to the cornua; the thyro-hoïdean membrane, to its lower border. The anterior surface gives attachment to the stylo-hyoïd, sterno-hyoïd, and digastric muscles; the superior border, to the genio-glossi, genio-hyoïd, and middle constrictor of the pharynx; its lower border, to the omo-hyoïd and thyro-hyoïd muscles.

The Teeth.

89. In the adult sixteen teeth are implanted into each jaw, each of which is divisible into three parts, viz. a *root*, which is concealed in the alveolus; a *crown*, or head, projecting externally; and an intermediate part, or *neck*, which connects them. The root and centre of each are composed

of osseous matter as dense and hard as the petrous portion of the temporal bone, and the crown is encased by a layer of white, excessively hard substance, called enamel. This, towards the superior and lateral parts of the crown, is thick, but gradually becomes thin at the neck, and disappears at the commencement of the root. Within the body of each tooth is a cavity, which decreases in size as we advance in years; it is lined by a membrane, on which the nutritious vessels ramify, after having entered through minute foramina in the apices of the roots.

This vascular membrane constitutes the pulp of the tooth, and is abundantly supplied with vessels, and nerves derived from the dental branch of the fifth pair, which in its course through the dental canal, sends filaments up to each tooth. In early infancy the margin of each jaw forms a continuous ridge, covered by the mucous membrane of the mouth; but when examined internally, it is found to contain a certain number of membranous follicles, separated by thin partitions. Each of these is composed of two membranes; the internal one, thin and firm, forms a shut sac, and receives the ramifications of the dental vessels: the external one, thick and spongy, appears to be continuous with the periosteum of the jaw at the border of the socket, into which it descends, lining it as far as the point where the vessels enter; on these it is reflected, and ascends to the internal sacculus, the exterior of which it invests as far as the entrance of the vessels; there it is again reflected to the alveolus, which it lines. Such is the general conformation of the sacculi up to the fourth month of fœtal life; at which period the process of ossification begins, and proceeds as follows. At the bottom of the sacculus (adopting that term as a means of distinguishing the internal membrane, or shut sac, from the external one which is reflected over it) a soft, vascular mass arises, supplied with vessels and nerves, derived from those ramified on the sacculus. This mass gradually increases, and assumes the form of the tooth and constitutes as it were the model on which it is to be moulded. The osseous matter begins to be deposited first on its free surface, in a thin lamella, corresponding with the crown of the tooth; or rather in dots or scales corresponding with each of the inequalities on its upper surface, and gradually uniting to form a lamella. When the breadth is completed, the growth in length begins, and extends from the crown to the roots by successive depositions on the exterior of the pulp; so that it may be said to clothe itself in osseous matter, the roots being the parts last formed, the crown first. The bony lamella is at first remarkably thin, and the contained cavity of considerable size; but as the former increases in thickness by successive depositions on its inner surface, the latter and its inclosed pulp, become proportionally diminished, until the roots and body of the tooth have acquired their proper degree of thickness.

The enamel also is first deposited on the free surface of the tooth, being secreted by the external membrane, which is reflected over the sacculus in the first instance, and afterwards over the crown of the tooth when ossification has been established. It is at first soft, semi-fluid, and easily separable from the bone, as in after-life it may be separated by the application of heat. When the ossification has reached the root, the tooth can no longer be confined within the alveolus; it forces its way through the portion of the reflected membrane corresponding with its crown; then through a dense substance placed along the alveolar border of the jaw, and which is seen to elevate the mucous membrane in the form of a ridge; finally it pierces the latter, and makes its appearance within the cavity of the mouth. Thus the principle of eccentric development obtains throughout the entire process of the growth of the teeth, the particles of matter being first deposited at the points most remote from the centre: still it is not strictly analogous with what builders term over-hand work, for it not only proceeds from without to within, but begins at the top, and thence descends to the bottom. This principle should never be lost sight of by those who enter on a consideration of the theories of life and organization.

90. The teeth are divided into four classes, viz. the *incisores*, *cuspidati*, or *canini*, *bicuspidati*, or small molares, and the large *molares*.

The *incisors*, four in number in each jaw, are situated at the fore part of the mouth; their summit is wedge-shaped, being thin and sharp at the free border, slightly compressed at the sides, somewhat convex in front, and flat or concave behind. Those in the upper jaw are larger than those of the lower; the roots of all are single, elongated, and conical.

The *canine* teeth, placed at each side of the incisors, are two in number in each jaw. Their crown, convex anteriorly, concave behind, tapers towards its summit, where it ends in a blunted point; at its base are two transverse lines. Their roots, single, conical, and compressed at the sides, are longer than those of any other teeth.

The *bicuspidati*, four in number in each jaw, are so named from having two roots. They are intermediate in size, as well as in situation, between the canine and molar teeth. Their crown, compressed laterally where it is in apposition with the other teeth, is rounded on the external and internal sides. Their cutting extremities present two tubercles, one internal, the other external, the latter being the larger. The section of the neck is oval; the root is often single as far as its point, where it is slightly bifid.

The *molar* teeth, compressed on the sides as well as from before backwards, assume a cuboïd form at the crown; their upper surface, intended for trituration, is surmounted by four small tubercles, two on the inner, two on the outer border; which are separated from one another by a crucial depression. The last of this set are the smallest, and as they appear at a more advanced period of life, they are usually named *dentes sapientiæ*. The roots are divided into three, four, and sometimes only two diverging processes.

Remarks on the General Conformation of the Skull.

The bones of the skull, and those of the face, are joined together by seams or sutures. The cranial sutures are five in number, of which three are termed true, as the margins of the bones are, in a manner, dove-tailed one into another; and two are called false, or *squamous*, as they merely overlap one another, like the scales of fishes. The true sutures are 1, the *coronal*, which connects the frontal and parietal bones; it extends obliquely over the arch of the skull, and is so named from being situated where the ancients wore their *coronæ*, or garlands. 2. The *lambdoïdal*, which is situated between the occipital, parietal, and temporal bones, its form resembling, somewhat, that of the Greek letter Λ, whence its name. 3. The *sagittal* extends directly backwards, from the middle of the coronal to that of the lambdoïdal suture, and connects the two parietal bones; in children, and occasionally in adults, more particularly in females, it is prolonged through the frontal bone, even to the root of the nose. The serrated appearance of the sutures is perceptible only on the external surface of the bones, their internal surface, or table of each, as it is called, being merely in apposition with the contiguous bone.

The *squamous* sutures are arched, and mark the junction of the lower borders of the parietal bones with the squamous parts of the temporal. The line of direction of the sutures is not unfrequently interrupted by additional bones, inserted between those hitherto enumerated. These, from being sometimes of a triangular form, are called *ossa triquetra,* and also *ossa Wormiana*, from Wormius, an anatomist, who gave a detailed description of them.

The cranial bones are joined to those of the face by five sutures, which are common to both sets of bones. The *transverse* suture, observable at the root of the nose, extends across the orbits, and connects the frontal with the nasal, superior maxillary, ossa unguis, the ethmoïd, sphenoïd, and malar bones. The *zigomatic* sutures, directed obliquely downwards and backwards, join the zigomatic processes of the temporal with the malar bones. The *ethmoïd* suture surrounds the bone of the same name; so does the *sphenoïd,* which must be complex and irregular, in consequence of the many relations of the sphenoïd bone. The lines of connexion between the nasal and maxillary bones, though sufficiently marked, have not received particular names; but those observable between the horizontal lamellæ of the latter, and those of the palate bones, may be termed the palato-maxillary sutures.

After having described, in detail, the separate bones of the head and face, it becomes necessary to review them collectively. The description of these bones forms the most difficult part of human, as well as of comparative osteology, as they are the most complex in the whole skeleton; but a correct knowledge of them is indispensable, in consequence of the many important parts which they serve to sustain and inclose; viz. the cerebral mass, with its nerves and vessels; the organs of sight, hearing, smell, and taste; part of those of mastication and deglutition, as well as of voice. To facilitate the description of the numerous eminences, depressions, cavities, and foramina of the skull, anatomists examine, successively, its external and internal surface; the former may be considered as divisible into five regions, three being somewhat of an oval figure, and situated, one superiorly, another at the base, the third in front, including the face; the others comprise the lateral parts, and are somewhat flat and triangular. The *superior region* extends from the frontal eminences to the occipital protuberance, and, transversely, from one temporal ridge to the other; it thus includes the upper third of the frontal, almost all the parietal, and the superior third of the occipital bone, which together form the vaulted arch of the skull. It is divided into two symmetrical parts, by the sagittal suture; it presents no aperture or other inequality deserving of notice, is covered by the common integument and occipito-frontalis muscle, on which ramify branches of the temporal, occipital, and auricular arteries, as well as filaments of nerves from the frontal branches of the fifth and portio dura, and also from the occipital nerve. The *inferior region*, also oval in its outline, is the most complex of all, as it includes the entire base of the skull, extending from the symphysis of the chin to the occipital protuberance; and transversely, from the mastoïd process and base of the lower jaw at one side, to the corresponding points on the other. It may be considered as divisible into three parts. Of these one corresponds with the extent of the arch of the palate; is divided into two parts, by a line extending from before backwards, and marking the junction of the palate processes of the maxillary and palate bones; this is intersected by another, running transversely between each palate bone and the corresponding maxillary bone. Anteriorly, and in the middle line, is a foramen (the *anterior palatine*,) which, in the floor of the nares, is double, but becomes single inferiorly, and transmits the naso-palatine nerve and artery; on each side, and at the base of the alveolar border is another foramen (*posterior palatine*,) for the posterior palatine nerves and artery. The anterior boundary of this region, being formed by the alveolar borders of both jaws, and the body of the lower one, presents those several eminences, depressions, and foramina, already enumerated in the descriptions of the bones. The middle, or guttural region, extends from the pterygoïd processes as far as the mastoïd processes, thus including the posterior aperture of the nares, and the central part of the base of the skull. In the centre is situated the basilar process of the occipital bone, marked by slight inequalities, for the attachment of muscles, and towards its posterior extremity, the anterior condyloid foramina, which transmit the ninth pair of nerves. On each side is the pars petrosa of the temporal bone, in which may be observed the styloïd and vaginal processes; more posteriorly, the jugular fossa, which is completed into a foramen, (*foramen lacerum posterius*) by the border of the occipital bone. This is divided into two parts by a spicula of bone, or a fibrous band, the internal and anterior one serving to transmit the glosso-pharyngeal, par vagum, and spinal accessory nerves, the other the jugular vein. Between the apex of the pars petrosa, and the side of the basilar process, and the body of the sphenoïd bone, is the *foramen lacerum anterius*, which is nearly closed by cartilage, and transmits the vidian nerve, after it has passed backwards through the pterygoïd foramen, in the base of the process of the same name. Between the contiguous margins of the pars petrosa and the great ala of the sphenoïd bone is a groove, which leads backwards and outwards, and lodges the cartilaginous part of the Eustachian tube; and beside the osseous part of that tube, and separated from it by a thin lamella of bone, is the orifice of the canal which transmits the tensor tympani muscle. The foramina of this region, taken in their order, from within outwards and backwards, are, the foramen ovale, foramen spinosum, foramen caroticum, and stylo-mastoïdeum.

The anterior part of this region is continuous with the posterior aperture of the nares, which is divided into two parts by the vomer. It is bounded above by the body of the sphenoïd bone, below by the palate plates of the ossa palati, and on the sides by the pterygoïd processes. The pterygoïd groove, inclosed by these processes, is completed inferiorly by the pyramidal process of the palate bone; near its junction with the body of the bone is the digital cavity, for the origin of the circumflexus palati; and, at its inferior termination, is the hamular process, round which the tendon of that muscle is reflected. Between the base of this process and the posterior palatine foramen, are situated one or two smaller foramina, leading down from the posterior palatine canal, and which transmit one or two small branches from the descending or posterior palatine artery and nerve.

The posterior part of the inferior region includes all that is situated between the occipital protuberance, and a line connecting the mastoïd processes. It is divided into two lateral parts by a ridge, extending to the foramen magnum from the occipital protuberance, from which two rough curved lines branch outwards, giving attachment to muscles; as do also the spaces between the lines, and that between the inferior one and the foramen magnum. On the margins of the foramen, but nearer to its anterior termination, are the condyles, which articulate with the first vertebra; behind each is a rough depression (*condyloïd fossa*,) and usually a foramen, (*posterior condyloïd foramen*,) which transmits a small vein and artery.

The *anterior region* of the skull is of an oval form, and extends from the frontal eminences to the chin, and from the external border of the orbit and ramus of the jaw, on one side, to the corresponding points on the other, so as to include the whole of the face. The eminences, depressions, fossæ, and foramina, observable in this region, are as follows, viz. the frontal eminences, more or less prominent in different individuals, bounded inferiorly by two slight depressions, which separate them from the superciliary ridges; these curve outwards, from the nasal process of the frontal bone. Beneath the superciliary ridge, on each side, is the margin of the orbit, marked, at its inner third, by a groove, or a foramen, which transmits the frontal nerve and supra-orbital artery; and also by a slight depression, which gives attachment to the cartilaginous pulley of the trochlearis muscle. At an interval, corresponding with the breadth of the orbit, is another ridge, forming its inferior margin; under which is situated the infra-orbital foramen, for the passage of the superior maxillary nerve; and still lower down, the fossa canina, which gives attachment to the levator anguli oris muscle, and is bounded below by the alveolar border of the upper jaw, and externally by the malar tuberosity. Towards the middle line, and corresponding with the interval between the orbits, is the nasal eminence, which is prominent in proportion to the development of the frontal sinuses, over which it is situated. This is bounded by the transverse suture, marking the root of the nose. Beneath the nasal, and between the contiguous borders of the superior maxillary bones, is a triangular opening which leads into the nasal fossæ. Farther down is the transverse rima of the mouth, between the alveolar borders of the jaws. In the inferior maxillary bone, besides some muscular impressions, is the mental foramen, which transmits the terminal branches of the dental nerve and artery.

The two *lateral* regions are somewhat of a triangular figure, the apex of the triangle being at the angle of the lower jaw, the base at the temporal ridge, and the sides formed by two lines drawn one upwards and forwards, over the external orbital process, the other upwards and backwards, over the mastoïd process. In consequence of the great irregularity of the surface, it is necessary to subdivide each of these regions into three; the part above the zigoma being called the temporal region, or fossa; that beneath it, the zigomatic; the remainder being named the mastoïd. The *temporal* region, or fossa, being bounded by the temporal ridge above, and by the zigomatic arch below, is of a semicircular form, and extends from the external angular process of the orbit to the base of the mastoïd process. It is filled up by the temporal muscle, and is formed by the temporal, parietal, frontal, sphenoïd, and malar bones. The mastoïd region is bounded before by the transverse root of the zigoma, above by the horizontal one, behind and inferiorly, by the additamentum suturæ lambdoidalis. Proceeding from behind forwards, we observe the mastoïd foramen, the process of the same name; anterior to which is the aperture of the meatus auditorius externus, which is circular in young subjects and oval in adults, the greatest diameter being from above downwards. The osseous tube continuous, externally, with the fibroaperture of the nares, which is divided into two parts by the vomer. It is bounded above by the body of the sphenoïd bone, below by the palate plates of the ossa palati, and on the sides by the pterygoïd processes. The pterygoïd groove, inclosed by these processes, is completed inferiorly by the pyramidal process of the palate bone; near its junction with the body of the bone is the digital cavity, for the origin of the circumflexus palati; and, at its inferior termination, is the hamular process, round which the tendon of that muscle is reflected. Between the base of this process and the posterior palatine foramen, are situated one or two smaller foramina, leading down from the posterior palatine canal, and which transmit one or two small branches from the descending or posterior palatine artery and nerve.

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The *zigomatic* region, situated behind and beneath the orbit, is bounded before by the convex part of the superior maxillary bone, and is inclosed between the zigoma and the pterygoïd process. The posterior surface of the maxillary bone is pierced by some small foramina, opening into canals, for the transmission of the dental nerves. Between the superior border of this bone, and the great ala of the sphenoïd, is a fissure (*spheno-maxillary*,) which is directed forwards and outwards, and communicates with the orbit; and between its posterior border and the pterygoïd process is another, (*pterygo-maxillary*) whose direction is vertical. The angle formed by the union of these fissures constitutes the *spheno-maxillary fossa*, which is situated before the base of the pterygoïd process, behind the summit, or posterior termination, of the orbit, and immediately external to the nasal fossæ, from which it is separated by the perpendicular plate of the palate bone. Into this narrow spot five foramina open, viz. the foramen rotundum, which gives passage to the second branch of the fifth pair; the foramen pterygoïdeum, to the vidian or pterygoïd nerve and artery; the pterygo-palatine, to a small artery of the same name, (sometimes called also the superior pharyngeal); the posterior palatine foramen leading to the canal of the same name, and the spheno-palatine, which transmits the arteria nasalis and spheno-palatine nerve.

The *internal surface* of the skull may be divided into its arch and its base. The arch extends from the base of the perpendicular part of the frontal bone, as far as the internal occipital ridge. Along the middle line, and corresponding with the direction of the sagittal suture, is a shallow groove, marking the course of the superior longitudinal sinus. Several slight irregular depressions may also be observed, for the cerebral convolutions, and some tortuous lines for the branches of the meningeal artery. The surface is somewhat depressed at the points corresponding with the frontal and parietal eminences; and also above the internal occipital ridge, where the posterior lobes of the brain are lodged.

The *base* of the skull presents the several eminences, depressions, and foramina, which have been already enumerated in the description of the separate bones. Three fossæ may be observed on each side, differing in size and depth; the anterior one formed by the orbital plate of the frontal bone and the smaller wing of the sphenoïd, serves to support the anterior lobe of the brain; it is marked by eminences and depressions, corresponding with the cerebral convolutions and sulci; and, posteriorly, by a transverse line, indicating the junction of the bones just mentioned. The middle fossa, formed by the great ala of the sphenoïd, the squamous part of the temporal, and the anterior surface of the pars petrosa, lodges the middle lobe of the brain. It is marked by linear impressions, for the meningeal artery, and by shallow grooves, for the cerebral convolutions; anteriorly it opens into the orbit by the sphenoïdal fissure, which transmits the third, fourth, the ophthalmic branch of the fifth, and the sixth pair of nerves, together with the ophthalmic vein. Behind this is situated the foramen rotundum, for the second branch of the fifth, the foramen ovale, for the third, and, lastly, the foramen spinosum, for the middle meningeal artery. At the junction of the pars petrosa with the body of the sphenoïd, is the internal orifice of the carotid canal; on the anterior surface of the pars petrosa, and directed obliquely backwards, is a slight groove, leading to the hiatus Fallopii, and transmitting the vidian nerve. The posterior fossa, deeper and broader than the others, gives lodgment to the lateral lobes of the cerebellum. In the posterior surface of the pars petrosa, which forms the boundary of this fossa, may be observed the internal auditory foramen, and, within a few lines of it, a triangular fissure, which opens into the aquæductus vestibuli, and towards its inferior margin, the groove for the lateral sinus, which leads down to the foramen lacerum posterius. Along the middle line, and taking the parts situated in the base of the skull, from before backwards, we observe the crista galli of the ethmoïd bone; and, on each side, the cribriform lamella of that bone. Farther back, a slightly depressed surface, which supports the commissure of the optic nerves, and, on each side, the optic foramina. Behind this is the pituitary fossa, situated on the body of the sphenoïd bone, bounded before and behind by the clinoïd processes. Leading downwards and backwards from these is the basilar groove, which supports the pons varolii and medulla oblongata, and terminates at the foramen magnum; on each side of this foramen are the condyloïd foramina, and behind it a crista, leading upwards to the occipital ridge, and giving attachment to the falx cerebelli.

The Orbits.

The form of the orbits is that of a quadrilateral pyramid, whose base is directed forwards and outwards, and apex backwards and inwards, so that if their axes were prolonged backwards they would decussate on the body of the sphenoïd bone.

The *roof*, which forms part of the floor for the brain, is concave, and composed of the orbitar process of the frontal, and the smaller wing of the sphenoïd bone; at its anterior and inner border may be observed a depression for the attachment of the pulley of the trochlearis muscle; externally, and immediately within the margin of the orbit, a shallow depression for the lachrymal gland; at the anterior border, a groove, sometimes a foramen, which transmits the supra-orbital artery and nerve; and, posteriorly, at the apex of the cavity, the optic foramen, transmitting the optic nerve and ophthalmic artery. The *floor* forms the roof of the maxillary sinus; it consists of the orbitar processes of the malar and maxillary bones, and of the small portion of the palate bone which rests on the latter; towards the inner and anterior border, near the lachrymal canal, may be observed, a slight roughness for the attachment of the obliquus inferior muscle; posteriorly, a groove, terminating in the infra-orbitar canal, which runs nearly horizontally forwards. The *internal surface* runs directly backwards, being parallel with the corresponding side of the other orbit, and is composed of the ascending process of the maxillary bone, the os unguis, the os planum, of the ethmoïd, and part of the body of the sphenoïd bone. Near the anterior border is situated the *lachrymal canal*, which is formed, for the most part, between the ascending process and body of the maxillary bone, the remainder being made up by the groove in the os unguis, and a small process of the inferior spongy bone; this canal, a little expanded at its extremities, is directed downwards, backwards, and a little outwards. The *outer surface* of the orbit, composed of the orbitar plates of the malar and sphenoïd bones, presents some minute foramina, which transmit small nerves from the orbit to the temporal fossa.

The *superior internal angle*, formed by the junction of the orbital process of the frontal bone, the os unguis, and os planum, presents two, and sometimes three foramina (*foramen orbitare, internum anterius, et posterius,*) which give transmission, the anterior to the nasal twig of the ophthalmic nerve, the posterior to the ethmoïdal artery. The *internal inferior angle* is formed by the union of the os unguis, os planum, and the maxillary and palate bones. In the *external angle*, formed by the malar, frontal, and sphenoïd bones, is observed the sphenoïd fissure, of a triangular form, situated obliquely, its base being internal and inferior, the apex external and superior. In the *inferior external angle* is situated the spheno-maxillary fissure, inclined at an angle with the former, and communicating with it, but of a different form, being broad at its extremities, and narrow at the centre. This latter is formed by the malar, the great ala of the sphenoïd, the maxillary and palate bones.

The *anterior extremity*, or *base*, of the orbit, is directed outwards and forwards, and, as if to provide for a free range of lateral vision, the external wall retreats in some degree, and does not extend as far forward as the internal. In each orbit, parts of seven bones are observed, viz. the frontal, ethmoïd, sphenoïd, os unguis, malar, maxillary, and palate bones; but as three of these, viz. the ethmoïd, sphenoïd, and frontal, are common to both, there are only eleven bones for the two orbits.

The Nasal Fossæ.

These fossæ are two irregular cavities, placed at each side of the median line, separated by a flat, vertical septum. They communicate, by foramina, with the various sinuses lodged in the frontal, ethmoïd, and superior maxillary bones, and open anteriorly, on the surface, by the nares, and posteriorly, into the pharynx. The roof, the floor, the inner, and the outer walls of these cavities, require a separate consideration.

The *roof* is arched, and is formed in front by the inner surface of the nasal bones, behind, by the body of the sphenoïd, and in the middle, by the horizontal or cribriform lamella of the ethmoïd bone. The *floor* smooth, concave from side to side, and formed by the palate plates of the maxillary and palate bones, extends backwards, and a little downwards, from the nares to the pharynx. Towards the anterior opening may be observed the superior orifice of the anterior palatine canal. The *internal wall*, or septum narium, which extends from the roof to the floor of the cavity, is flat, nearly vertical, (the deviation, if any, being usually to the left side) and composed of the perpendicular plate of the ethmoïd bone, the vomer, and the nasal cartilage. The *external wall*, narrowed superiorly, extended inferiorly, is formed by the ethmoïd, superior maxillary, os unguis, inferior spongy, and palate bones. The posterior and inferior parts of this surface are marked by a number of inequalities, whilst the superior and anterior are comparatively even. In the latter situation may be observed, first, the smooth surface just mentioned; and, secondly, passing downwards and backwards, three, and frequently four, arched and convoluted bones (spongy bones,) beneath which are grooves (*meatus*) leading from before backwards. Beneath the superior spongy bone is the *superior meatus*, into which may be observed, opening anteriorly, a foramen from the posterior ethmoïdal cells, and, posteriorly, the spheno-palatine foramen. Under the second is the *middle meatus*, which communicates with the anterior ethmoïdal cells; one of these may be observed to curve forwards and upwards, and is continuous with the frontal sinus; more posteriorly is situated the opening of the maxillary sinus. The *inferior meatus*, situated below the inferior spongy bone, between it and the floor of the nasal cavity, is necessarily longer than the others; it presents anteriorly the orifice of the nasal canal.

The Frontal Sinuses.

The *frontal sinuses* correspond with the superciliary eminences of the frontal bone. Of considerable size in the adult, but varying in different individuals, they are not at all developed in the fœtus. They are divided into two, sometimes three compartments.

The *sphenoïdal sinuses*, usually two, sometimes three in number, placed within the body of the sphenoïd bone; these also cannot be said to exist in infancy. They are separated by one, or when three exist, by two partitions. Above, behind, and on each side, they are bounded by the body of the sphenoïd bone, and in front, by two small spongy portions of the ethmoïd bone.

The *maxillary sinus*, (*antrum Highmorianum*) occupies the superior maxillary bone. It appears at an earlier period than any of the other sinuses, the development commencing about the fourth month of fœtal life. Its form is irregularly pyramidal, the base being towards the nasal cavity, the apex corresponding with the malar tuberosity. Superiorly, it is inclosed by the orbitar plate of the maxillary bone; and inferiorly, by its palate plate; internally, it opens into the middle meatus of the nasal cavity by a foramen, which, though it appears very large in the dry bone, separated from its connexions, is, in the natural state, very small, being nearly sufficient for the admission of a probe; this diminution of size is caused by the inferior spongy and palate bones, and also by a fold of the mucous membrane.

Every part of the conformation of the human subject indicates its adaptation to the erect position. The feet are broader than those of any other animal proportionally to its size; the tarsal and metatarsal bones admit of very little motion, and the great toe is on the same plane with the others, and cannot be brought into opposition with them. The foot is thus fitted to sustain the weight of the body, but not to grasp or seize objects presented to it. The hands on the contrary, though so well adapted for these purposes, are ill calculated for affording support, so that man is truly bimanus and biped.* The tibia rests perpendicularly on the astragalus, and the os calcis projects backwards for the purpose of increasing the base, and also of lengthening the lever to which the strong muscles of the calf are attached. The whole extent of the tarsus, metatarsus, and phalanges in man, rests on the ground, which does not obtain in any other animal; even in apes the end of the os calcis is somewhat raised so as to form an acute angle with the bones of the leg. In dogs and digitated quadrupeds, the carpus and tarsus are considerably elevated from the ground, so that the body rests on the toes; and in the horse, and other solid-hooved animals, the third phalanges only rest on the ground, the os calcis being raised nearly to the perpendicular direction.

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* *Règne Animal*, tom. i. p. 82.

The femur, placed securely beneath the pelvis, affords a firm support during progression. The great breadth of the pelvis serves to enlarge the base on which the trunk rests; and this is farther increased by the length of the cervix femoris. This peculiarity in the neck of the femur renders it necessary that the body of the bone should incline inwards, in order that its axis should approach the central line, and so support the centre of gravity. If its articular head be viewed in profile, it will be observed that the cartilaginous coating is distributed for the most part on its upper and inner aspect, showing its adaptation as a pillar of support in the erect position.

The bones of the pelvis in the human subject are distinguished from those of other animals by some marked peculiarities. The sacrum is remarkably broad and expanded, so as to form a firm support for the spinal column which rests upon it; its lower part is curved and articulated with the coccyx, so that both incline forwards and enclose the cavity, constituting a support for the viscera when pressed down by muscular action. If a different arrangement of these bones obtained, if they were continued downwards in a straight line, they would project beyond the ischia and render the sitting posture irksome or impossible.

The spinal column, which is supported on the pelvis, is peculiarly adapted to the erect attitude. Its pyramidal form and enlarged base fit it to sustain the superincumbent weight; and by means of the different curvatures which it presents, a considerable range of motion is allowed to the trunk, the centre of gravity being still supported within the base. The form of the thorax is also peculiar. Shallow and compressed from before backwards, it is broad and expanded from side to side, by which means the preponderance of the trunk forwards is considerably lessened. The sternum, though broad, is very short, so that a considerable space intervenes between it and the pubis, which is occupied solely by muscular parts. The thorax in quadrupeds is compressed and flattened laterally, becoming gradually narrower towards the sternum, which is prominent and keel-shaped, so that the breadth from this latter bone to the spine is much greater than that from side to side. This conformation, together with the absence of clavicles in true quadrupeds, enables the anterior extremities to approach closely together, and fall perpendicularly downwards beneath the trunk, so as to give it a steady support. The sternum is elongated in these animals, and the ribs pass from the spine to that bone so directly without making any angle, that they approach near to the crista of the ilea, and thereby increase the extent of firm support necessary to sustain the weight of the viscera. Even with these advantages the muscles of the abdomen would be inadequate to the support of its contents, were they not assisted by a layer of elastic substance, which is placed over their entire extent, and which of itself marks their destination for the prone position.

Though the upper and lower extremities present several points of similitude, they yet may be contrasted so as to shew that they are adapted to totally different purposes. It is quite obvious that the scapula and os innominatum, the humerus, and the femur, the bones of the fore-arm and those of the leg, the hand and the foot, are respectively constructed on the same plan ; but the differences which they present indicate a difference of function.

The scapulæ placed on the supero-posterior part of the trunk, are borne off by the clavicles ; their glenoïd cavities are directed forwards and outwards, so that the arms, which are as it were appended to them, are fitted to enjoy a considerable degree of motion in the anterior and lateral directions. But in true quadrupeds the glenoïd cavities look directly downwards, and are approximated closely together, so that the thoracic limbs which are articulated with them, project downwards beneath the fore part of the trunk ; and as they are thus calculated to support its weight, they possess little lateral motion. The glenoïd cavity in man is quite shallow, so that the globular head of the humerus is merely applied to its surface ; but the acetabulum is a deep cup-like cavity, indicating a quite different destination in the two joints. The breadth of the articular surfaces of the knee-joint, and the peculiar conformation of the ankle-joint, as contrasted with the elbow and wrist, are abundantly sufficient to shew that fixity and strength have been designed in the one, mobility in the other. This difference is, if possible, more strongly marked in the conformation of the hand and foot, the latter, as has been already observed, being intended to support the body, is placed at right angles beneath the leg, the former is continuous with the line of direction of the fore-arm, otherwise it could not be guided with sufficient precision to the different objects which it is intended to seize. The tarsal bones are large, firm, and strong; those of the metatarsus are also thick and large, and placed all in a line. That which supports the great toe being the stoutest of all, and almost immoveable, ranges with the others. But the metacarpal bones are quite differently disposed; that which supports the thumb admits of considerable motion in every direction, so as to perform a complete circumduction, and is placed so much out of line with the others, that it can be opposed to them, as in grasping different objects. The hand and foot may be considered as divisible, each into two parts, differing in their degrees of mobility, viz. the digital phalanges, and the row of bones which sustains them. The moveable phalanges of the hand are as long as the carpal and metacarpal bones taken together, but in the foot they are not a third of the length of the tarsal and metatarsal bones.

No part of the osseous system of man affords more striking evidence of his adaptation for the erect posture, than the cranium. Resting on the summit of the vertebral column, the line of its base forms a right angle with that of the column itself, which thus affords it a firm support. The condyles, or points of articulation, are situated very near the centre of its base, being however a little nearer to the occipital protuberance than to the anterior surface of the jaws; by this arrangement very little active power is required to maintain it in *equilibrio*.* In other animals the condyles are placed much further back, so that instead of resting on the column, the skull is, as it were, appended to its extremity, and is sustained by an elastic substance, the ligamentum nuchæ, which is attached by one extremity to the spinous processes of the vertebræ, and by the other to the occipital protuberance. The head, as has been already observed, is composed of two parts, the cranium and face; the one being intended to contain the brain, or the material instrument of the mind, the other to enclose the organs of sight, smell, and taste. The more the organs of smell and taste are developed, the greater is the size of the face, and the greater its relative proportion to the cranium. On the contrary, the larger the brain, the greater must be the capacity of the skull, and the greater its proportion to the face. On this principle a large cranium and a small face indicate a large brain with a restricted development of the sense of smell and taste; but a small cranium and a large face mark an opposite conformation. The character and nature of animals is determined by the degree of energy with which their different functions are performed; they are guided and impelled by some leading propensity or disposition; and as the cranium and face bear to the brain and organs of sense the relation of containing and contained parts, the study of their relative proportions is one of great interest to the naturalist, inasmuch as they serve as indices of the faculties, instincts, and capabilities of different individuals, as well as of classes.

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* Lawrence *on the Characters of the Human Head*, passim.

Several methods have been suggested for determining the proportion of the cranium to the face; the simplest is that of Camper. If a line be drawn upwards from the side of the chin, over the most prominent part of the forehead, it will form an angle with a horizontal line drawn backwards over the external auditory foramen from the margin of the anterior nares; the size of the angle will indicate the degree of development of the cranium and brain, as compared with that of the face and organs of sense. In the crocodile these lines are co-incident, there is therefore no appreciable angle.

In the Horse it measures*	23°
Ram	30
Dog	35
Ouran-outang	56 to 60
European adult	85

Thus we find man at the top of the scale of animated beings, distinguished from all the rest as well by his external conformation and deportment, as by his internal organization. When the mind has passed in review the many links of the chain which connects the lowest with the highest—the mere animated dot, with man, the lord of the creation, it cannot fail to be struck with astonishment at the immense chasm which separates them. Yet when each link of the chain is compared with that which precedes and follows it, the transition from the one to the other is found to be so gradual, as to be almost imperceptible. So easy are the steps of ascent from the organization of the higher orders of the quadrumana, up to the human species, that even Linnæus felt it difficult to assign the specific characters by which man is distinguishable from all others; but any doubt that may have existed on this subject has been long since removed. The physical and moral attributes of man are universally recognized as sufficient to elevate him much further from the higher mammalia, than they are from the classes beneath them; and in the opinion of Cuvier,[*] he should be considered not merely as a distinct species, but even as forming a separate order by himself. Whether then with the zoologist we consider the physical conformation of man as compared with that of other animals, or with the moralist reflect on his mental power and high destination, we can scarcely refrain from saying, with the poet,

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* Cuvier *Leçons d'Anatomie Comparée*, tom. ii. p. 8.

> Sanctius his animal mentisque capacius altæ
> Deerat adhuc, et quod dominari in cætera possit,
> Natus est homo.

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[*] *Règne Animal*, tom. i. p. 81.

CHAPTER III.

THE ARTICULATIONS.

91. The different pieces of the osseous system being connected together so as to form the skeleton, their modes of union must be as various as their forms and uses. The connecting media are ligament, cartilage, fibro-cartilage, and fibrous membrane, variously arranged and disposed, permitting, in some instances, no perceptible motion; in others, allowing a free and extended range in every direction; still all the varieties, however numerous, are usually included under the general term—articulation.

92. The articulations are divided into three classes; viz. the immoveable, the moveable, and mixed; the last being intermediate in degree between the others. The first form obtains where flat and broad bones are united to enclose cavities for the lodgement of important organs, as in the cranium and pelvis. In some instances the surfaces are indented and reciprocally impacted one into the other, so that complete solidity is insured by the structure of the part; and as this mode of union occurs only amongst flat bones, their deficiency in extent of contact is compensated by the indentations in their margins. There is another set of immoveable articulations, in which the surfaces are merely in apposition with one another, yet total immobility is secured by what may be termed a mechanical contrivance. Thus, though the squamous part of the temporal bone merely rests against the inferior border of the parietal, no motion can exist between them, in consequence of the manner in which the petrous portion of the former bone projects into the base of the skull.

93. All the bones of the head and face, except the lower

jaw, are joined by immoveable articulation, or *synarthrosis*, (συν, *together*, αρθρον, *articulation*) of which there are several forms.

a. The first is called *suture* (*sutura, a seam*). In the true suture the union is effected by indentations in the contiguous margins of bones being mutually received into one another, as may be seen between the two parietal, the occipital, and frontal bones, any varieties that occur being referrible to the form of the prominences. Thus when they are tooth-shaped, the suture is termed *sutura dentata;* if like the teeth of a saw, *sutura serrata;* if the adjacent borders be bevilled off, as where the temporal and parietal bones are applied to one another, it is called a squamous suture (*sutura squamosa*). In some parts it may be observed that the mode of union and adaptation are alternated, in order to increase their power of resistance. Thus, at the superior part of the arch of the skull, the frontal overlays the parietal bones, and rests on them, but inferiorly and laterally the reverse takes place, where the parietal rests against the frontal.

b. When the surfaces are merely placed in apposition with one another, as in the superior maxillary bones, the union is called *harmonia*, (αρω, *to adapt*).

c. When a ridge in one bone is received into a groove in another, the articulation is called *schindylesis* (σχινδυλησις, a *slit* or *fissure*). The rostrum of the sphenoïd, and the descending plate of the ethmoïd bone, are joined in this way with the vomer. When a conical surface is impacted into a cavity, the term *gomphosis* (γομφος, *a nail*) is adopted, which may be exemplified by the manner in which the teeth are lodged in the alveoli.

94. The mixed form of articulation, or *amphi-arthrosis*, resembles the immoveable, in having the bones connected by an intermediate substance, and the moveable ones in admitting of some degree of motion between the surfaces. The articulations between the different vertebræ, the union at

the symphysis pubis, and that between the two first bones of the sternum, are all constructed on this principle. As the surfaces in these cases are flat and broad they possess in themselves no mechanical advantage, so that their union is maintained partly by the cartilages interposed between them, and partly by ligamentous and fibrous structures disposed round the articulations.

95. In the moveable articulations, or *diarthrosis* (δια, *through; αρθρον, articulation*), as the surfaces are merely in contact with one another, the connexion between the parts is maintained by means of ligaments and fibrous membranes; for, though cartilages are interposed between their adjacent extremities, they do not form a bond of union between them, as they are calculated to facilitate motion, rather than to restrain it. But the muscles which surround the different moveable articulations contribute materially to retain the articular surfaces in their natural situations, and to prevent displacement. This is particularly evident in the shoulder joint, in which the head of the humerus is kept in contact with the glenoïd cavity, not so much by the fibrous capsule, which is weak and loose, as by the surrounding muscles; for if these be weakened by paralysis, luxation may be readily produced. The joints in the extremities are all referrible to the moveable class, so is that of the lower jaw with the skull, and of the latter with the vertebral column. In the greater number of instances one of the articular surfaces is convex, the other concave, but each of these forms exhibits some varieties of conformation, which are designated by particular names. Thus an articulating eminence, rounded and globular, so as to form a segment of a sphere, is called a *head;* but if it be elongated, the term *condyle* is used. These are in some cases, supported by a contracted or thin portion (*neck*), which connects them with the body of the bone. If two condyles be placed in apposition, so as to leave a fossa between them, and constitute a pulley-like surface, it is termed *trochlea*. When plane, even surfaces

articulate, it is not necessary to mark them by any particular name; in describing them they are referred to generally as articulating surfaces. Some of the articulating depressions have also received names taken from certain peculiarities in their conformation. Thus the superior extremity of the ulna, which receives the trochlea of the humerus, is called the sigmoïd cavity, from some resemblance to the Greek letter Σ (*σιγμα, εἰδος, like*); others are denominated from their greater or less degree of depth or shallowness. The deep cup-shaped cavity which receives the head of the femur, is called cotyloïd, (from κοτυλη, *a cup*, and εἰδος, *like*), and the shallow oval depression to which the head of the humerus is applied, receives the name of *glenoïd* cavity (from γληνη, *a cavity*, and εἰδος, *like*).

96. As the extent and form of the articulating surfaces of joints, as well as their ligamentous connexions, vary in different instances, so must their degrees of solidity and mobility: and on a review of the whole of the articulations it may be laid down as a general principle that the greater their mobility, the less their solidity; or in other words, that the one is inversely as the other. All the motions, however, which are admissible in joints, may be arranged under four heads, viz. 1st, motions of angular opposition; 2nd, of circumduction; 3rd, of rotation; 4th, of gliding. Each of these deserves a separate consideration.

1st. The motion of opposition, or the angular movement, can only take place between long bones. If these be made to move in opposite directions, as from extension to flexion, or from abduction to adduction, they form with one another angles varying in degree according to the extent of the motion. This in some cases, as in the elbow and knee, is confined to flexion and extension, which makes them strictly hinge-joints (*ginglimus*, a hinge); in others the motion is general, and extends to four opposite directions, including each of the points intermediate between them, as may be observed in the shoulder, in the hip, and the metacarpal joint of the thumb, all which joints admit of a circumduction in the part, to which they belong.

2nd. The motion of *circumduction* is performed when the shaft of a bone is made to describe a cone, its summit corresponding with the superior articulation, the base being at the inferior extremity of the bone. While this motion is being executed, the limb passes successively through the states of elevation, abduction, depression, adduction, and of course through all the intermediate points; and, if a pencil be held between the fingers, and its point applied to any plane surface, such as a wall, it will trace a circle corresponding with the base of a cone, whose summit is at the shoulder joint, whilst its side coincides with the line described by the outstretched limb, as it traverses the different points just enumerated.

3rd. *Rotation* differs altogether from circumduction. In the latter, the bone suffers a change of place, as it moves from one point to another; in the former, it merely turns on its own axis, and therefore retains the same relative situation with respect to the adjacent parts. This movement, however, admits of two varieties; in one, it is performed on a pivot, as in the motion of the axis on the dentata vertebra; in the other there is a sort of compound motion, for instance, where the radius rolls on its own axis at one end, whilst at the other it moves upon the extremity of the ulna, by which its lower part describes a segment of a circle, and therefore changes place to a certain extent. The femur and humerus also admit of a rotatory motion; in the latter, as the head is closely applied upon the shaft, the axis of motion nearly coincides with that of the bone; but in the former, in consequence of the length of the neck, and of the angle which it forms with the bone, the rotation is performed round an imaginary axis, which may be conceived to pass from the globular head to the condyles.

4. Besides these more obvious movements, the contigu-

ous surfaces of every moveable articulation admit a certain degree of *gliding* motion upon one another, so that it may be regarded as common to all; but in some cases it is the only one which takes place, for instance, between the different bones of the carpus and tarsus. We thus observe that some joints admit of all these motions, some are deprived of rotation, retaining the rest, whilst in others nothing more than a mere gliding can take place between the surfaces, so that a regular gradation is established in their degrees of mobility between the most moveable, and those which are least so. The shoulder-joint admits of the greatest extent and variety of movement; those between the carpal and tarsal bones are exceedingly limited in these particulars; and finally, between the latter, and those which are altogether immoveable, an intermediate grade may be traced, for instance in the pubic symphysis.

97. There are but two articulations in which all the motions of opposition, circumduction, and rotation, can be performed, namely, the hip and shoulder joints. In these a convex is applied to a concave surface, the former being hemispherical, which is essentially necessary to such a freedom of motion. As joints constructed on this principle are more liable to displacement than any others, their security is in a great measure provided for by their being placed at the superior or central extremity of the limb, by which they are withdrawn from the influence of external forces. This arrangement is made subservient, not to the security of the joint solely, but also to a very important purpose in the functions of the limb. For, as these free and extended motions are performed in the superior articulation, their effect is communicated to the whole limb, so as to compensate for the more restricted movements in the lower joints.

98. Though all the motions abovementioned take place in the hip and shoulder joints, each of them considered singly is not performed with equal facility in both. Thus, circumduction is executed with greater ease in the shoulder

than in the hip. Rotation, on the contrary, is more free and perfect in the latter than in the former. Circumduction can be executed with ease only when the axis of motion coincides (or very nearly so) with that of the lever to be moved, as is the case in the humerus; but in the femur the length of the neck of the bone removes the axis of motion considerably from that of the shaft, and thereby impedes circumduction in proportion as it facilitates the rotation of the limb. These differences of structure in the superior joints of the two extremities bear a direct relation to the conformation of their other articulations, and to the purposes for which they are adapted. For, as the inferior extremity is intended to sustain the weight of the body, and for progression, the bones of the leg must be securely fixed, which could be effected only by diminishing their mobility; on this account no rotation or supination is allowed between the tibia and fibula, but to compensate for this deficiency, rotation is permitted in the hip. But, as the superior extremity, on the contrary, is fitted for the prehension of objects, and for quick and varied movements, free motion is allowed between the bones of the fore arm, and between the latter and the carpus, in order that the hand and fingers may be more readily directed and applied to such objects as are required to be seized for different purposes, and the power of pronation and supination thus conferred more than compensates for any deficiency in the rotatory motion of the humerus.

99. It has been already observed, that rotatory motion in a bone presupposes the existence of a globular head, placed so that its axis shall form an angle with the shaft. Wherever this requisite is wanted, motion is confined to opposition and circumduction, as occurs in the articulation of the thumb with the carpus, in the phalanges with the metacarpal bones, and in the clavicle with the sternum. In these joints the articulating surfaces are placed at the ends of the more moveable bones, and as their axes

coincide with that of motion, rotation is prevented, but circumduction and opposition are freely performed. When these are limited in extent, as in the sterno-clavicular articulation, it arises rather from the accessory ligaments of the part than from any impediment in the surfaces of the bones; and, if motion in one direction be more free than in another, as in the digital phalanges with the metacarpus, where flexion and extension are more free than abduction and adduction, it proceeds partly from the existence of the lateral ligaments, and partly from the greater power of the flexor and extensor muscles. Though in the knee and elbow the axis of motion coincides with that of the bones, yet their movement is confined to two directions, viz. to flexion and extension. In these joints all other motions besides those just mentioned are prevented by the breadth of the articulating surfaces, and by their mode of adaptation; however, when they are flexed, some degree of lateral motion, and also of circumduction, can be performed, as any individual may ascertain by resting his elbow on a table, when he will find that the fore-arm may be made to describe a cone with its summit at the olecranon and base, towards the fingers.

The Articulations of the Trunk.

100. The vertebræ are connected at every point of their circumference by ligaments, or fibro-cartilage, and in some parts by synovial membranes, the former serving to retain them in their situation, the latter to facilitate motion between the different bones. The bodies are joined by two ligamentous bands, extending the whole length of the chain, and also by the inter-vertebral substances.

1. *The anterior common ligament* (*ligamentum commune anterius*, Weitbrecht. Soemmering,) placed on the front of the bodies of the vertebræ, reaches from the axis to the first bone of the sacrum, becoming broader as it descends. The superficial fibres extend from a given vertebra to the

fourth or fifth below it; the set subjacent to these passes from the body of one to about the third beneath it, whilst the deeper ones pass only from one vertebra to that next it. The fibres are thicker towards the middle of the bodies of the vertebræ than at their margins, or over the inter-vertebral cartilages, by which means their transverse depressions are filled up, and the surface of the column rendered even. Laterally the fibres are thin and scattered, and reach from one vertebra to the other.

2. The *posterior common ligament* (*ligamentum commune posterius*, Weit. Soemm.) situated within the spinal canal, and attached to the posterior surface of the bodies of the vertebræ, extends from the axis to the sacrum. It is smooth, shining, and broader opposite the inter-vertebral cartilage, than opposite the body of the bone. In the greater part of its extent it adheres firmly to the bodies of the vertebræ, and is separated from the prolongation of the dura mater lining the canal by loose cellular tissue; but towards the top of the neck, the dura mater is so intimately connected with these structures, that it requires care to separate them. This arises from the fact, that whilst within the cranium, it serves the purpose of lining the bones and investing the brain; but in the spinal canal it merely encloses the medulla, the bones being lined by their proper fibrous structures, so that the division begins at the point just referred to.

3. The *inter-vertebral substance* (*ligamenta inter-vertebralia*, Weit.) is made up of narrow plates of fibro-cartilage, laid on their edges between each pair of vertebræ, and intimately connected with their contiguous surfaces. They are disposed concentrically, and correspond, at the anterior part of their circumference, with the anterior common ligament, and at the opposite with the posterior. In the interstices between these is deposited an elastic pulpy substance, the quantity of which is greatest towards the centre.

101. The *articulation of the spinous processes* is effected

by means of the supra-spinous and inter-spinous ligaments. 1. The *supra-spinous ligament* consists of small, compressed bundles of longitudinal fibres, which connect the summits of the spinous processes, and form a continuous chain from the seventh cervical vertebra to the spine of the sacrum. The posterior fibres pass down from a given vertebra to the third or fourth below it, those more deeply seated, reach only from one to the next, or the second beneath it. 2. The *inter-spinous ligaments*, thin and rather membranous, extend from the root to near the summit of each spinous process, connecting the inferior border of one with the superior border of that next below it. They exist in the dorsal and lumbar regions only, and are intimately connected with the extensor muscles of the spine. The *inter-transverse ligaments* are found only between the transverse processes of the inferior dorsal vertebræ, and can be demonstrated more clearly anteriorly, for they are united so intimately with the sacro-lumbalis, that their fibres are quite indistinct posteriorly.

102. The arches, or plates of the vertebræ are connected by the *ligamenta subflava*, (*ligamenta vertebrarum subflava*, Weit.) as their bodies are by the inter-vertebral cartilages. These consist of yellow elastic fibres, almost perpendicular in their direction, as they pass from the inferior border of one arch to the adjacent border of that immediately below it. They extend from the root of the transverse processes at each side backwards to the point where the two arches converge at the origin of the spinous processes, where the margins of each lateral half of the ligament may be observed to be merely in contact. The superior border of the ligament is attached, not to the margin only of the arch, but also for some way on its anterior surface; whilst the inferior border is prolonged a little on the posterior surface as well as the margin of its corresponding arch. They do not exist in the first inter-vertebral space, or between the occiput and atlas.

103. The *articulating processes* are connected by irre-

gular fibrous bands (*ligamenta processuum obliquorum*, Weit.) forming a capsule outside the synovial membranes. These are longer and more loose in the cervical than in the dorsal or lumbar regions.

The Articulations of the Cranium.

104. The cranium is articulated, 1, with the atlas; 2, with the axis; 3, with the lower jaw.

The articulation of the cranium with the atlas takes place between the condyles of the occipital bone and the superior articulating processes of that vertebra, which are connected by ligaments and synovial membranes.

105. The *anterior occipito-atloïdean ligament* (*membrana annuli anterioris vertebræ primæ*) extends from the anterior border of the occipital foramen between the condyles, to the margin of the arch of the atlas between its superior articulating processes. This is thin, broad, and membranous, but in the median line, a sort of accessory ligament is placed in front of it, which is thick, round, and composed of vertical fibres, attached above to the surface of the basilar process, and below to the small tubercle on the front of the atlas. The anterior surface of these ligaments is covered by the recti antici muscles, the posterior covers the odontoïd process and its ligaments.

106. The *posterior occipito-atloïdean ligament*, also broad and membranous, is attached superiorly to all that part of the margin of the occipital foramen which is behind the condyles, and inferiorly to the adjacent border of the posterior arch of the atlas. It consists of two lamellæ, which are united at their superior attachment, but soon divide, one becoming blended with the dura mater, which lines the canal; the other inserted into the arch of the atlas. The posterior surface of the ligament is in apposition with the posterior recti and superior oblique muscles, the anterior looks towards the vertebral canal.

The articulation of the occipital bone with the axis is effected through the medium of ligaments, as no part of their surfaces come into contact.

107. The *odontoïd ligaments* (*ligamenta alaria*) are two thick bundles of fibres attached below to each side of the summit of the odontoïd process, and passing up diverging to be implanted into the rough depression at the inner side of the condyles of the occiput, and also to a small part of the margin of the occipital foramen. Their direction therefore is obliquely upwards and outwards; the triangular interval which they thus leave is filled by some thin fibres passing almost perpendicularly from the margin of the foramen to the summit of the process. These are strictly check ligaments; the middle set last described prevent what may be termed a retroversion of the head, whilst the lateral pair check its rotatory motions.

108. The *occipito-axoïdean ligament* seems to be a prolongation of the posterior common ligament; it is attached above to the inner surface of the basilar groove, from which it descends perpendicularly, becoming narrow, and opposite the axis is blended with the posterior common ligament. It covers the odontoïd process and its check ligaments, and is intimately connected with the transverse ligament.

109. The *articulation of the axis with the atlas* is effected not only by means of their articulating processes, as occurs in other vertebræ, but also by the odontoïd process of the latter, which is connected in a particular manner with the arch of the former, and constitutes the pivot on which the head turns in its rotatory motions. There are three ligaments and four synovial membranes in this articulation.

110. The *transverse ligament* (*ligamentum Atlantis transversum*, Weit. Soemm.) is a strong, thick fasciculus of fibres, compressed from before backwards, arched in its direction, and attached on each side to the inner border of the superior articulating processes of the atlas. From its posterior surface a short, thin bundle of fibres passes down to be attached to the roof of the odontoïd process, whilst another

passes up to the basilar process. These appendages form a cross with the transverse ligament, and serve to bind the occiput to the two first vertebræ; from this is derived the term *cruciform*, which is sometimes applied to the transverse ligament.

111. The *anterior atlo-axoïd ligament* passes from the border of the lesser arch of the atlas, and its tubercle, to the body of the axis and the root of its odontoïd process. It is thin and membranous.

112. The *posterior atlo-axoïd ligament* connects the posterior arch of the atlas with the plates of the axis. Thus the interstices between the plates or arches, which in all the other vertebræ are filled by the ligamenta subflava, are occupied by membrane between the second and first, as well as between the latter and the occiput.

Two synovial membranes are placed between the articulating processes of the atlas and axis. One between the odontoïd process and the transverse ligament, another between it and the arch of the atlas.

The Articulations of the Ribs.

The ligaments of the ribs may be divided into three sets: 1, those which connect them with the bodies of the vertebræ; 2, with their transverse processes; 3, with the sternum.

113. The *costo-vertebral ligaments* (*ligamenta capituli costarum*) consist: 1. Of an anterior ligament which connects the head of each rib with the sides of the bodies of the vertebræ; its fibres, flat and radiated, are divided into three bundles, of which the middle one passes horizontally forwards upon the corresponding inter-vertebral cartilage, whilst the superior ascends to the body of the vertebra above it, and the inferior descends to that below. From the divergence of its fibres this is usually called the *stellate ligament*. 2ndly. Of an *inter-articular ligament*, which is a band of fibres passing transversely from the head of the

rib to the inter-vertebral substance, and dividing the articulation into two parts, each lined by a separate synovial membrane. This ligament does not exist in the articulation of the first, eleventh, or twelfth ribs, and in consequence there is in them but one synovial capsule.

114. The *costo-transverse ligaments* connect the tubercles of the ribs with the extremities of the transverse processes of the vertebræ. They are divided into a posterior and an anterior set. 1. The *posterior costo-transverse ligament* (*lig. transversum externum costarum*, Weit.) consists of a short thick fasciculus of fibres which passes from the posterior surface of the summit of the transverse process, to the rough unarticulated part of the tubercle of the rib. Those of the superior ribs ascend, those of the inferior descend somewhat. 2. The *anterior costo-transverse ligament* (*lig. transversum internum costarum*, Weit.) is usually divided into two fasciculi of fibres, both nearly in apposition and on the same plane. They pass from the neck of the rib and the border near its tubercle, upwards and backwards to the lower margin of the transverse process next above it. These do not exist in the articulations of the first and last ribs. The articulations between the tubercles of the ribs and the transverse processes are provided with synovial capsules.

115. The *costo-sternal articulations*, situated between the anterior extremities of the cartilages of the ribs and the fossæ, in the margins of the sternum, are composed, 1, of an anterior set of fibres, thin, scattered, and radiated, passing from the extremity of the cartilage to the anterior surface of the sternum, where they interlace with those of the opposite side, and are blended with the aponeurosis of the pectoralis major muscle. 2. Of a posterior set of fibres similarly disposed, but not so thick or numerous, connecting the thoracic surfaces of the same parts. 3. Of a synovial membrane, interposed between the ends of each true rib and the sternum, and also between the margins of each pair of

false ribs, where they articulate with one another. These can be readily demonstrated by slicing off a little of the anterior surface of the sternum and cartilages. A thin fasciculus of fibres connects the cartilage of the seventh rib with the xiphoïd cartilage, and thence called the *costo-xiphoïd ligament.* The three pieces of the sternum are connected by a layer of fibro-cartilage placed between their contiguous borders; and, on the anterior and posterior surfaces, some scattered fibres may be observed running longitudinally from above downwards, which serve to strengthen their connexion. These are sometimes called the anterior and posterior sternal ligaments.

The Articulation of the Lower Jaw.

The lower jaw articulates at each side by one of its condyles with the glenoïd cavity, and with the smooth surface on the anterior root of the zigomatic process. By means of an inter-articular cartilage a double joint is formed at each side, with distinct synovial membranes, so that the temporo-maxillary articulation is provided with four of these shut sacs.

116. The *external lateral ligament* is a short fasciculus of fibres, attached above to the external surface of the zigoma, and to the tubercle at the bifurcation of its root, below to the external surface, and posterior border of the neck of the condyle, its fibres being directed downwards and backwards. Externally it is covered by the parotid gland, internally it is in relation with the inter-articular cartilage and synovial membranes.

117. The *internal lateral ligament,* thin, loose, and elongated, extends from the spinous process of the sphenoïd bone downwards, and a little forwards, to be attached to the lower border of the dental foramen, where it is somewhat expanded. Its external surface is in relation superiorly with the external pterygoïd muscle, and in the rest of its extent with the ramus of the jaw, from which it is separat-

ed by the internal maxillary artery and dental nerve. Its inner surface is concealed by the internal pterygoïd muscle.

118. The *stylo-maxillary ligament,* thin and aponeurotic, passes from near the point of the styloïd process to the inner border of the angle of the jaw, where it is interposed between the masseter and internal pterygoïd muscles.

119. The *inter-articular cartilage,* oval, elongated from before backwards, thicker at its margins than at the centre, where it is sometimes perforated, is placed horizontally between the articular surfaces. Its inferior surface, which is in contact with the condyle, is concave; the superior, concave from before backwards, is a little convex from side to side towards its two extremities, conforming in some way with the outline of the glenoïd cavity. Its circumference is connected at each side with the lateral ligaments, and anteriorly with the external pterygoïd muscle.

The synovial membrane, after lining the upper surface of the inter-articular cartilage, is reflected upwards on the lateral ligaments, and over the smooth part of the glenoïd cavity; a similar membrane is interposed between the inferior surface of the cartilage and the condyle, so as to constitute a double joint.

Of the Articulations of the Superior Extremities.

These may be arranged under the following heads, taking them in their anatomical order, from above downwards: 1, the articulation between the trunk and the limbs; 2, those of the scapula; 3, of the elbow; 4, of the wrist; 5, of the hand; 6, of the fingers.

120. The superior extremity has but one point of bony attachment to the trunk, namely, that at the sterno-clavicular articulation, the scapula being connected with the trunk, and head by muscles only. The clavicle is connected with the first bone of the sternum, its fellow of the opposite side, and the first rib, by the following ligaments.

1. The *anterior sterno-clavicular ligament* passes from

the inner extremity of the clavicle, downwards and inwards, upon the surface of the sternum. It is broad, and consists of parallel fibres, and corresponds internally with the synovial membrane of the articulation, externally with the sternal origin of the sterno-mastoïd muscle.

2. The *posterior sterno-clavicular ligament*, of similar conformation with the last, but not so broad or strongly marked, is placed between the same bones lying at the thoracic aspect of the joint. Its posterior surface is in relation with the sterno-hyoïdeus and sterno-thyroïdeus muscles.

3. The *inter-clavicular ligament* is a dense fasciculus of fibres, placed transversely between the contiguous extremities of the clavicles. Its fibres do not pass directly across from one to the other; they dip down, are attached to the upper margin of the sternum, by which it is rendered concave from side to side.

4. The *costo-clavicular ligament* (*ligamentum rhomboïdes*, Weit. Soemm.) does not properly form part of the articulation; yet it contributes materially to retain the clavicle in its situation. It is attached inferiorly to the cartilage of the first rib near its sternal end, and passes obliquely backwards and upwards, to be fixed to a roughness at the under surface of the clavicle.

5. The *inter-articular cartilage*, nearly circular in its form, and thicker at its border than at the centre, is interposed between the articulating surfaces of the sternum and clavicle. Towards its superior and posterior part it is attached to the margin of the clavicle, and at the opposite point with the cartilage of the first rib. In the latter situation it is thin, and somewhat prolonged, so that the inferior border of the clavicle rests upon it. In this articulation, as in that of the lower jaw, there are two synovial membranes, of which one is reflected over the sternal end of the clavicle and adjacent surface of the fibro-cartilage, the other is disposed similarly between the cartilage and the articulating surface of the sternum.

121. The *scapulo-clavicular articulation* is effected between the acromion process, and the external end of the clavicle, which are connected, 1st, by a *superior ligament*, which is a strong broad band of fibres, passing from the superior surface of the acromion, to the adjacent extremity of the clavicle; 2ndly, by an *inferior ligament* similar to the preceding, and placed at the posterior surfaces of the same bones; 3rdly, by a synovial membrane lining the two articular surfaces of the bones. As there is an inter-articular cartilage, there are sometimes two synovial sacs disposed in the same way as those in the sterno-clavicular articulation.

122. The *coraco-clavicular ligament*, which connects the clavicle with the coracoïd process of the scapula, presents two parts, each marked by a particular name. There is, however, no division betwen them, nor other distinction, than that they look different ways.

The *posterior* or *internal fasciculus*, (*conoïd ligament*), broad above, narrow below, is attached inferiorly to the root of the coracoïd process; superiorly, to a rough space at the inferior surface of the clavicle, its fibres being directed backwards and upwards. The *anterior* or *external fasciculus* (*trapezoïd ligament*) passes from the superior surface of the coracoïd process upwards, to an oblique line extending to the end of the clavicle from the tuberosity to which the conoïd ligament is inserted; with the latter it unites at an angle, one of its aspects being directed forwards and upwards, the other downwards and backwards.

123. There are two ligaments proper to the scapula. 1. The *coracoïd ligament* (*ligamentum proprium posterius*) is a thin flat band of fibres, attached by its extremities to the opposite margins of the notch, at the root of the coracoïd process, which it thus converts into a foramen, for the transmission (most commonly) of the supra-scapular nerve, the artery passing external to it. 2. The *coraco-acromion ligament* (*ligamentum proprium anterius*) is a broad, firm, triangular fasciculus, attached by its broader extremity to

the coracoïd process, and by the narrower to the acromion, between which it is stretched almost horizontally. Its inferior surface looks downwards upon the shoulder joint, the superior is covered by the deltoïd muscle.

Of the Shoulder Joint.

124. The globular head of the humerus and the glenoïd cavity of the scapula, are the osseous parts which compose this articulation (*scapulo-humeral*). As the head of the humerus is large and prominent, whilst the cavity is merely a superficial depression, it must be evident that they are retained in their situation not by any mechanical contrivance, but by the capsular ligament, and the muscles which are attached to the two tuberosities of the humerus.

125. The *capsular ligament* is attached superiorly round the margin of the glenoïd cavity, and inferiorly round the neck of the humerus. It is broader in the latter than in the former situation, and its laxity is such, that if the muscular connexions of the humerus be detached, it drops away from the glenoïd cavity. The superior and inner part of this membrane is covered and strengthened by a bundle of fibres passing outwards and forwards from the coracoïd process to the great tuberosity of the humerus (*coraco-humeral ligament*). Besides this it receives additions from the tendons of the supra and infra spinatus muscles, from the teres minor and subscapularis, which are intimately connected with it, as they proceed to be attached to the tuberosities. Thus its superior part is thick and firm, the inferior comparatively thin and weak. Its internal surface is in apposition with the synovial membrane; the external, besides the muscles already mentioned, is covered by the deltoïd; inferiorly, it is in relation with the long head of the triceps and the circumflex vessels. The insertion of its inferior border is interrupted to give passage to the long tendon of the biceps muscle.

126. The *glenoïd ligament* appears to be continuous with

the tendon of the long head of the biceps muscle, which at its point of attachment to the superior margin of the glenoïd cavity, separates into two sets of fibres, which after embracing it, meet and unite inferiorly. These fibres by elevating the border of the cavity, render it a little deeper.

127. The *synovial membrane*, after lining the glenoïd cavity, is reflected over its lower margin until it reaches the inner surface of the fibrous capsule, on which it is prolonged as far as the neck of the humerus, where it separates from the capsule, and is applied upon the articular surface of the head of that bone, giving it a smooth investment. At the bicipital groove, the membrane passes down, for about an inch below the margin of the articular cartilage, where it is reflected upon the tendon of the biceps, which guides it to the superior border of the glenoïd cavity. Commencing again at the insertion of this tendon, but passing from its upper aspect, we trace the membrane along the superior portion of the capsule, and for some way into the bicipital groove, where it is reflected on the tendon, and so passes back to the point from which we set out. The tendon of the biceps by this arrangement is enclosed in a tube or sheath, formed by the synovial membrane, which invests it when about to pierce the fibrous capsule, so as to maintain the integrity of the articulation.

On the superior and external surface of the capsule, a considerable bursa mucosa is situated, by means of which the contiguous surfaces of the coracoïd and acromion processes, and of the coraco-acromion ligament, are rendered smooth and lubricated to facilitate their movements on the subjacent capsule.

128. The *coraco-humeral*, or accessory ligament extends obliquely over the superior and inner part of the articulation; it is attached to the coracoïd process, and thence descends, intimately connected with the capsule, to the greater tuberosity of the humerus.

Of the Elbow Joint.

129. The inferior extremity of the humerus, the ulna, and radius, are united at the elbow, so as to form a hinge joint. The sigmoïd cavity of the ulna articulates with the trochlea of the humerus, so as to admit of flexion and extension only, while the cup-shaped depression on the head of the radius, can turn freely on the rounded tuberosity to which it is applied. The bones are connected by four ligaments and a synovial membrane.

1. The *internal lateral ligament*, composed of diverging and radiated fibres, presents two parts, each with a different aspect, one looking forwards, the other backwards. The anterior part is attached above, where it is narrow and pointed, to the front of the internal condyle of the humerus; its fibres, as they descend, become broad and expanded, and are inserted into the coronoïd process, along the anterior margin of the sigmoïd cavity. The posterior part of the same form (triangular) passes from the under and back part of the same process of bone, downwards to the inner border of the olecranon. The superior fibres extend transversely between these points, the rest become successively more and more oblique.

2. The *external lateral ligament*, shorter and much narrower than the internal, is attached superiorly to the external condyle of the humerus, and inferiorly becomes blended with the annular ligament of the radius; none of its fibres are prolonged to the surface of that bone, for if they were, they would check its rotatory motions. It is intimately connected with the tendinous attachment of the extensor muscles, on which account when dissected, it presents a jagged, irregular appearance.

3. The *anterior ligament*, is a broad thin membrane, placed in front of the joint, extending from the rough margin of the fossa, which receives the coronoïd process during flexion, downwards to the anterior border of the coro-

noïd process, and to the annular ligament of the radius. Some of its fibres are directed obliquely downwards and outwards, others are vertical.

The *posterior ligament*, loose and weak, consists of fibres proceeding in opposite directions; those of the posterior layer pass transversely between the adjacent margins of the fossa, which receives the head of the olecranon; the other set subjacent to these, but not very well marked, pass vertically from the superior concave margin of that fossa, to the extremity of the olecranon.

130. Though these structures are described and named as separate ligaments, it will be found on examination, that they form a continuous membrane placed round the joint, as fibrous capsules usually are, except only that the irregularity of the surfaces to which they are attached, prevents their continuity from being readily perceived, and gives them the appearance of distinct ligamentous connexions, passing from one point of bone to another.

131. The head of the radius articulates with the sigmoïd cavity of the ulna, on which it rolls when it is made to turn on its axis. These surfaces are covered with cartilage, and invested by the synovial membrane of the elbow joint. The radius is connected to the ulna by an annular ligament.

132. The *annular* or *orbicular ligament*, is a strong band of circular fibres, which, by being attached to the borders of the lesser sigmoïd cavity, forms a ring, encircling the head of the radius, and binding it firmly in its situation. Its external surface is in apposition with the external lateral ligament of the elbow, whose fibres are identified with it; the internal is smooth and lined by the synovial membrane.

133. The *synovial membrane*, after having lined the articular extremity of the humerus, is prolonged a little on the anterior surface of that bone, as far as the attachment of the fibrous capsule, where it is reflected, and applied to its internal surface, lining it as far as its radio-cubital insertion; at that point the synovial membrane leaves the fibrous

one, and invests the articular surfaces of the radius and ulna, and is extended over them until it comes in apposition with the posterior part of the fibrous capsule, by which it is guided to the extremity of the humerus. Besides these reflexions, the membrane forms two pouches, one by being prolonged into the lesser sigmoïd cavity, the other where it passes between the annular ligament and the contiguous surface of the head of the radius.

When the joint is laid open and the bones extended, it will be observed that the head of the radius is not in contact with the tuberosity of the humerus. On which account in the extended state of the limb, the rotatory motions of this bone are performed with much less ease than in that of flexion, from its wanting support superiorly. The tuberosity of the humerus is moreover covered with cartilage only on its anterior aspect, indicating that the radius moves on it only when in the flexed position.

The interval between the radius and ulna in the fore-arm, is filled up by an interosseous ligament, and a round ligament, which serve to connect them together.

134. The *interosseous ligament* (*membrana interossea*) is a thin, flat, fibrous, membrane, the direction of its fibres being obliquely downwards and inwards, from the inner sharp border of the radius, to the contiguous one of the ulna. It does not reach the whole length of the bones, as it commences about an inch below the tubercle of the radius. The surfaces of this membrane are intimately connected with the deep seated muscles of the fore-arm, serving to extend their points of origin as well as to connect the bones. Inferiorly it leaves an opening for the transmission of the anterior interosseous vessels; superiorly, there is another but much larger interval, through which the posterior interosseous vessels pass.

135. The *round ligament* in some measure occupies the deficiency left by the interosseous ligament at the superior part of the arm. It is a thin narrow fasciculus of fibres, ex-

tending obliquely from the anterior surface of the coronoïd process, downwards and outwards, to be implanted on the radius, about half an inch below its tubercle. The direction of its fibres is therefore altogether different from that of the fibres of the interosseous ligament.

136. In the *inferior articulation* of the *radius* and *ulna*, the former rotates on the latter as its point of support, the articulating surface of the radius being concave, that of the ulna convex. The bones are connected anteriorly and posteriorly by some fibres passing between their extremities, so thin and scattered, as scarcely to admit or require description, but internally they are joined by a fibro-cartilage and a synovial membrane.

137. The *fibro-cartilage*, placed transversely between the bones, is attached by its base to a rough line separating the carpal from the ulnar articulating surfaces of the radius, and by its summit to a depression at the root of the styloïd process of the ulna. Its superior surface looks towards the head of the ulna, the inferior to the cuneïform bone; both are smooth and lined by synovial membrane; the inferior one by the large membrane of the wrist joint, the superior by a small one peculiar to the radio-cubital articulation. Its two borders are connected with the carpal ligaments. As the radius rolls on the ulna, this cartilage is carried with it, and forms its chief bond of union with the latter bone.

138. The *synovial membrane* is frequently called *membrana sacciformis*, though there is nothing in its conformation which distinguishes it from other synovial sacs. It may be considered as presenting two parts, or sacculi, one projecting perpendicularly upwards into the articulation of the radius and ulna, lining the contiguous surfaces of each, the other placed horizontally between the head of the ulna, and the corresponding surface of the fibro-cartilage lining them also; both however, are formed by a continuous membrane.

The Wrist Joint.

139. This articulation is formed by the radius and triangular cartilage above, and the three first bones of the carpus below. The articular aspect of the former, when viewed in the fresh state, presents an oval and slightly concave surface, its greatest breadth being from side to side. The surface of the radius is divided into two parts, by a line extending from before backwards, so that these, together with the cartilage, present three articular surfaces, one for each carpal bone. The scaphoïd, semi-lunar, and cuneïform bones are articulated together, so as to form a rounded convex surface, which is received into the concavity above described. Four ligaments and a synovial membrane retain these parts in their situation.

140. The *internal lateral ligament* passes directly downwards from the extremity of the styloïd process of the ulna, to be attached to the cuneïform bone; it also sends some fibres to the annular ligament and pisiform bone. Its form is that of a rounded cord; its inner surface is in contact with the triangular fibro-cartilage, the part above the cartilage being lined by the membrana sacciformis, that below it by the synovial membrane of the radio-carpal articulation.

141. The *external lateral ligament* extends from the styloïd process of the radius, to a rough surface on the scaphoïd bone, some of its fibres being prolonged to the trapezium, and also to the annular ligament of the wrist.

142. The *anterior ligament*, broad and membranous, is attached to the rough border of the carpal extremity of the radius, and to the base of its styloïd process, from which its fibres pass down to be inserted into the anterior surface of the scaphoïd, semi-lunar, and cuneïform bones. It is pierced by several foramina for the transmission of vessels; one of its surfaces is lined by the synovial membrane of the joint, the other is in contact with the tendons of the flexor muscles.

143. The *posterior ligament* extends obliquely downwards and inwards, from the extremity of the radius, to the posterior surface of the semi-lunar and cuneïform bones; its fibres appear to be prolonged for some way on the carpal bones. One surface is in contact with the synovial membrane, the other with the extensor tendons.

144. The *synovial membrane,* after having lined the articular surface of the radius, and the triangular fibro-cartilage, is reflected on the anterior and posterior ligaments, and thence over the surface of the carpal bones.

The Articulations of the Carpus.

The bones of the carpus consist of two sets, each united by its proper connexions, so as to form a row, both however being connected by fibrous bands and a synovial membrane common to them. The connexions proper to the first row are interosseous fibro-cartilages, and ligaments placed on their dorsal and palmar surfaces.

145. The *interosseous fibro-cartilages* are two lamellæ, one placed at each side of the semi-lunar bone, connecting it with the scaphoïd and cuneïform bones. The carpal extremity of these is smooth and lined by the synovial membrane of the wrist joint.

146. The *palmar* ligaments are two, one extending from the scaphoïd bone to the semi-lunar, the other from the semi-lunar to the cuneïform, their direction being transverse; and as their fibres are partly united, they may be considered as a continuous band connecting these bones.

147. The *dorsal ligaments* are also two, disposed similarly and connecting the same bones on their posterior surfaces. The pisiform bone stands out of the range, and rests on the palmar surface of the cuneïform, with which it is articulated by an irregular fibrous capsule and a synovial membrane.

The carpal bones of the second range are also connected by similar means. There are *three dorsal and palmar li-*

gaments passing transversely from one bone to the other. There are, however, but two *interosseous fibro-cartilages* placed one at each side of the os magnum, connecting it with the trapezoïd externally, and the unciform internally. Such are the means of connexion peculiar to each row; those common to both are an anterior, a posterior, and two lateral ligaments.

148. The *lateral ligaments* are placed one on the radial, the other on the ulnar border of the carpus; the former connecting the scaphoïd bone with the trapezium, the latter the cuneïform with the unciforme.

149. The *anterior ligament* consists of short fibres, passing obliquely from the bones of the first, to those of the second range. The *posterior* is similar in structure and arrangement.

It may be observed, that the first range of carpal bones forms a concavity, the second, particularly the magnum and unciform, a convexity received within it; by which means a ball and socket joint is formed, which is completed by a synovial membrane reflected over the articular surfaces of the different osseous pieces which compose it. It moreover sends two processes between the three bones of the first row, and three between those of the second, so as to facilitate their respective motions.

The Carpo-metacarpal Articulations.

150. The four last metacarpal bones are connected with those of the carpus, by means of two sets of fibrous bands, situated, one on the palmar, the other on the dorsal surface, the latter being better marked. All but the fifth metacarpal bone receive two bands. Thus to the second, or that of the fore-finger, a thin fasciculus of fibres passes from the trapezium, another from the trapezoïd bone; the third receives one from the latter and also from the os magnum, the fourth from the os magnum and also from the unciforme; but the fifth is connected to the latter only. On the

palmar surface, a similar mode of connexion exists, but the fibres are not so well defined.

The *carpal extremities* of the four last metacarpal bones, are bound together by three transverse fibrous bands on the palmar, and the same on the dorsal surface, passing from one to the other; they are very slight, and often ill-defined.

The *digital extremities* of these bones are connected at their palmar aspect by a flat band passing across them, and closely connected with the head of each; this is called the *transverse ligament.*

151. The *metacarpal bone of the thumb* is articulated on quite a different principle from the others; for as it admits of all the motions, except rotation, it is connected to the trapezium by a capsular ligament, which passes from the rough border, bounding its articular surface to the trapezium; these parts are lined by a synovial membrane.

The Articulation of the Phalanges with the Metacarpal Bones.

152. The rounded head of each of the four last metacarpal bones being received into the slight concavity situated in the extremity of the first phalanx, is maintained *in sitú* by two lateral ligaments, an anterior ligament and a synovial membrane.

153. The *lateral ligaments* consist of dense fasciculi of fibres, attached by one extremity to the sides of the metacarpal bones, by the other to the contiguous extremity of the phalanges, the direction of the fibres being forwards and downwards. The *anterior* ligaments occupy the interval between these on the palmar aspect of the joints; they are thin and membranous. The synovial membrane invests the surfaces of the heads of the bones, and is reflected on the ligaments which connect them.

154. The phalanges are articulated with one another, on the same principle as that which obtains in the articulation

between their bases and the metacarpal bones; it is therefore unnecessary to repeat what has been just stated on that subject.

155. There are some other fibrous and ligamentous structures which deserve to be noticed in this place, not as being connected immediately with the joints; they are rather accessories to the tendons of the muscles. Thus along the margins of the phalanges, on their palmar aspect, are attached the *vaginal ligaments*, which form sheaths for the flexor tendons, and bind them securely in their situation; these are thick and firm along the body of the phalanges, but over the flexures of the joints they are thin, so as not to impede their movements; their inner surface is lined by a fine membrane resembling the synovial class, which is reflected over the tendons, giving to each a smooth and shining appearance.

156. The *posterior annular ligament* of the wrist is continuous with the fascia of the fore-arm, of which it may be considered a part. It extends from the extremity of the radius to the inner border of the ulna and the pisiforme bone, and serves to bind down the extensor tendons.

157. The *anterior annular ligament* is a dense fasciculus of fibres, extended across the carpus from the pisiform and unciform bones, to the trapezium and scaphoïdes, so as to form a canal which transmits the flexor tendons, retains them in their situation, and modifies their direction and power of action on the hand.

The Articulations of the Pelvis.

158. The os sacrum considered as the common point of support of the vertebral column above, the os coccygis below, and ossa innominata on each side, is connected with each of these in the following manner:

1. *Sacro-vertebral articulation.* The base of the sacrum is articulated with the last lumbar vertebra, by the same means as those which connect the different pairs of vertebræ

throughout the column; 1, by an inter-vertebral substance placed between their oval surfaces; 2, by the continuation of the anterior and posterior common ligaments; 3, a ligamentum subflavum connecting the arches of the last vertebræ with the posterior border of the sacral canal; 4, an inter-spinous ligament; 5, two synovial membranes between the articulating processes, and lastly, a sacro-vertebral ligament. All these, except the last, being similar to the connecting media throughout the column, require no farther description in this place.

159. The *sacro-vertebral ligament* connects the summit of the transverse process of the last vertebra with the depressed lateral surface at the base of the sacrum; its form is triangular, as its fibres diverge and expand towards the sacro-iliac symphysis.

160. The *ileo-lumbar ligament* is extended horizontally between the summit of the transverse process of the last lumbar vertebra, and the posterior extremity of the crista of the ileum, where its fibres expand somewhat, so as to give it a triangular form. This is the only bond of union between the vertebral column and the os ileum.

161. The *sacro-coccygean articulation* is effected, 1, by an *anterior ligament,* consisting of irregular fibres, placed in front of these bones, subjacent to the rectum; 2, by a *posterior ligament* more strongly marked, composed of fibres which descend upon the bones of the coccyx, from the margin of the inferior orifice of the sacral canal, which it serves to close in and complete; 3, by a *fibro-cartilage* interposed between the contiguous extremities of the sacrum and coccyx.

162. The *sacro-iliac articulation,* often named the sacro-iliac symphysis, or synchondrosis, is formed between the rough lateral surfaces of the sacrum and ileum, closely applied to one another, and connected by an irregular lamella of a cartilaginous structure. In addition to these means of union, the pelvic bones are connected by the following ligaments.

163. The *posterior sacro-sciatic ligament*, (*lig. sacro-ischiadicum majus*, Weit. Soemm.) elongated, broad and triangular, is placed at the inferior and posterior part of the pelvis, whose lower aperture it assists materially in closing. Its base or broader part is attached to the postero-inferior spine of the ileum, and the side of the sacrum and coccyx, whilst its other extremity is fixed to the under surface of the tuber ischii, where it expands somewhat, and sends upwards and forwards along the margin of the ramus, of that bone, a falciform process, which presents one surface looking towards the perinæal space, and the other resting on the internal obturator muscle and pudic artery. The posterior surface of this ligament gives origin to part of the gluteus maximus; the anterior is covered partly by the small sacro-sciatic ligament.

164. The *anterior or small sacro-sciatic ligament*, (*lig. sacro-ischiadicum minus, internum*, Weit. Soemm.) is attached by its base to the side of the sacrum and coccyx, where its fibres are blended with those of the great ligament, and by its apex to the spinous process of the ischium; its form is triangular, the direction of its fibres forwards and outwards. The spinous process of the ischium, its tuberosity, and these two ligaments, bound an oval interval, through which the obturator internus muscle passes out from the pelvis; but above the border of the anterior ligament, is a larger oval opening, bounded before and above by the margin of the ileum and ischium, and behind by the great ligament, which transmits the pyramidalis muscle, the great sciatic nerve, the gluteal and ischiadic arteries.

165. The *posterior sacro-iliac ligaments* consist of three or four sets of short irregular fibres, extended transversely, between the posterior rough surface of the sacrum, and the adjacent part of the crista ilei; one of these extends from the posterior inferior spinous process of the latter, and is called the posterior spinous ligament; they are all placed

deeply in the groove formed by the ileum and sacrum, and covered by the origin of the lumbar muscles. The anterior sacro-iliac ligament consists of some thin irregular fibres, placed at the anterior aspect of the sacro-iliac symphysis, and attached to the pelvic surfaces of the sacrum and ileum.

166. The *pubic articulation* (*symphysis pubis*) is formed by the junction of the ossa pubis in the median line anteriorly. This is effected by an elongated piece of fibro-cartilage, interposed between their surfaces, and connected to each. It is thicker anteriorly than posteriorly, and consists of concentric lamellæ. This union is strengthened, 1st, by an *anterior pubic ligament*, which consists of irregular fibres, passing obliquely across from one bone to the other, and decussating on the anterior surface of the cartilage; 2ndly, the *sub pubic ligament*, (*ligamentum triangulare, arcuatum*,) thick and triangular, which is placed beneath the symphysis, its sides being attached to the rami of the pubis, its base free and slightly concave, directed downwards and backwards to the perinæal space.

167. The *obturator ligament* (*membrana obturans foraminis thyreoidis*, Soemm.) is properly a fibrous membrane, inserted into the border of the obturator foramen, which it closes in its entire extent, except at the superior part of its circumference, where a small oval aperture is left for the exit of the obturator vessels. The obturator muscles are attached to its surfaces.

The Hip Joint.

168. This is a true ball and socket joint, in which the globular head of the femur is received into the cotyloïd cavity. The articulating surfaces are covered by cartilage in the greater part of their extent. It is deficient however at the bottom of the cavity, and also a little beneath the central point of the head of the femur; the latter marking the insertion of the round ligament, the former a shallow fossa

for the lodgement of the structure, which has been called the synovial gland. The connecting means in this articulation, are three ligaments, viz. a capsular, cotyloïd, and inter-articular ligament, together with a synovial membrane.

169. The *capsular ligament*, dense and firm in its texture, represents a fibrous tube, whose direction is downwards and outwards; being attached by one extremity round the margin of the cotyloïd cavity; by the other to the neck of the femur. Its superior circumference in the greater part of its extent, is attached to the bone, within two or three lines of the cotyloïd ligament, but opposite the notch where the margin of the cavity is deficient, it is attached to the transverse ligament. Its inferior circumference is inserted in front into the oblique line leading from one trochanter to the other, but superiorly and behind, its fibres are implanted into the neck of the bone, within a quarter of an inch of the trochanteric fossa, and about the same distance from the posterior inter-trochanteric line. The ligament is most dense and firm towards the superior and anterior part of the articulation; inferiorly, its fibres are comparatively thin. A firm fasciculus of fibres extends obliquely downwards in front of the joint intimately connected with the capsule, being calculated to strengthen it, hence it is called its accessory ligament; but as one extremity of it is attached to the anterior inferior spinous process of the ileum, the other to the anterior trochanteric line, it may be called the *ileo-femoral* ligament. The joint is materially strengthened by the muscles surrounding it, particularly by the gluteus minimus, the external rotators, and the psoas and iliacus.

170. The *cotyloïd ligament* is a fibro-cartilaginous ring placed round the cavity, and serving the purpose of increasing its depth, and completing its border, where it is deficient. The broader part of this structure is attached to the bone, its thin edge is free, and both its surfaces are covered by the synovial membrane, the external being in contact with

the capsular ligament, the internal with the head of the femur. Its fibres are not continued all round; they rather pass obliquely from without inwards, over the margin of the cavity, one extremity being attached to the outer, the other to its inner surface. At the cotyloïd notch these fibres are continued from side to side crossing one another, so as to render the circumference complete. Some additional fibres are superadded in this part, from which circumstance, as well as its being stretched across from one margin of the notch to the other, it is usually named the *transverse ligament*. Subjacent to the transverse portion, an interval is left for the admission of the articular vessels.

171. The *inter-articular ligament* (*ligamentum teres capitis femoris*, Weit. Soemm.) is a thick dense fasciculus of fibres, implanted by one extremity which is round, into the fossa, in the head of the femur, by the other, where it is broad and bifid, into the margins of the cotyloïd notch, where its fibres become blended with those of the transverse ligament.

172. The *synovial membrane* lines the contiguous surfaces of all the parts which enter into the composition of the articulation, giving them a smooth and shining appearance. From the margin of the articular surface of the femur, it may be traced along the neck of that bone as far as the insertion of the capsular ligament, the inner surface of which it lines as far as its superior attachment. There it turns inwards over the cotyloïd ligament, and dips into the cavity, lining its entire extent, and finally guided as it were, by the round ligament, (which it invests by a funnel-shaped process) it reaches the head of the femur, and invests it as far as the border of its cartilage, from whence we proceeded in tracing its reflexions.

The Knee Joint.

173. This is a ginglimus, or hinge joint, formed by the condyles of the femur above, the head of the tibia below, and the patella in front, the contiguous surfaces of each being tipped with cartilage, and invested by a common synovial membrane. The following ligaments enter into the composition of the articulation: the ligamentum patellæ, the external and internal lateral, a posterior, a transverse, and two crucial ligaments; besides these may be enumerated two semi-lunar fibro-cartilages, and some folds of the synovial membrane, which have received names, viz. the ligamenta alaria and mucosum, but the term ligament cannot with propriety be applied to any other than fibrous structures which connect parts together.

174. The *ligamentum patellæ* is a flat strong band of tendinous fibres, which connects the patella with the anterior tuberosity of the tibia. Its superior extremity is attached to the apex of the patella, and to a depression on its posterior surface; its superficial fibres pass upwards on the anterior aspect of the bone, and become continuous with those of the tendon of the rectus femoris, the inferior extremity is a little expanded; towards the middle its borders are slightly tucked in. The anterior surface of this ligament is subcutaneous in its whole extent; the posterior rests on the synovial membrane, from which it is separated by some adipose substance, as it is inferiorly from the head of the tibia by a synovial bursa.

175. The *internal lateral ligament,* broad and flat, connects the tuberosity of the internal condyle of the femur with the inner surface of the head of the tibia. It becomes broad inferiorly, where it is covered by the tendons of the sartorius, gracilis, and semi-tendinosus muscles; internally it rests on the synovial membrane, and is attached to the internal semi-lunar cartilage.

176. The *external lateral ligament* is a rounded cord-

like fasciculus of fibres, which passes from the tuberosity of the external condyle of the femur, to the head of the fibula; its direction is vertical, but it is placed nearer the posterior than the anterior surface of the joint; its internal surface corresponds with the synovial membrane and the external articular arteries, the external being covered by the tendon of the biceps flexor cruris, and the expanded fascia of the extensor muscles. Posterior to this, but parallel with it, another ligament is placed, connecting the same points of the femur and fibula; it is called the *short external lateral ligament.*

177. The *posterior ligament* (*ligamentum posticum*) broad and expanded, is a flat plane of fibres, stretched obliquely behind the articulation, from the internal tuberosity of the tibia to the external condyle of the femur. The direction of the greater part of its fibres is from below upwards and outwards, running diagonally across the joint, being evidently continuous with the tendon of the semi-membranosus muscle, of which they may be regarded as a prolongation. This ligament, however, cannot be considered as formed solely by a reflexion of the tendon of the semi-membranosus, or merely as the third insertion of that muscle, for several transverse and perpendicular fibres are observed in it, distinct from those of the reflected tendon. A number of apertures may be observed between its fibres, which transmit the articular vessels.

178. The *crucial* or *oblique ligaments* (*ligamenta cruciata*) are placed at the posterior part of the joint, external to the synovial membrane, but partially invested by it. As the name imports, their direction is oblique, so that they cross or decussate somewhat like the lines of the letter X, the posterior one however approaches more nearly a perpendicular direction: of these one is anterior, the other posterior. The *anterior* is fixed by one extremity to a pit, situated before the spine of the tibia, where it is connected with the anterior cornu of the internal semi-lunar carti-

lage, by the other it is inserted into the inner side of the external condyle of the femur; hence its direction is upwards, backwards, and outwards. The *posterior ligament* is attached inferiorly to the pit behind the spine of the tibia, where it is intimately connected with the posterior cornu of the external semi-lunar cartilage, and superiorly, to the side of the inner condyle; its fibres being directed upwards and a little forwards. Its anterior surface is in contact with the last mentioned ligament, and the posterior with the ligamentum posticum. Both are thus implanted into the fossa between the condyles.

179. The *semi-lunar cartilages* are two crescent-shaped lamellæ of fibro-cartilage, placed on the articulating surfaces of the head of the tibia, interposed between them and the condyles of the femur. The outer border of each is thick and convex, the inner thin and concave, leaving the central part of the superior surface of the tibia uncovered. The *internal* one, elongated from before backwards, is nearly of a semicircular form, its anterior cornu is connected with the anterior crucial ligament, and is inserted into the pit before the spine of the tibia; the posterior attached behind the spine, is in relation with the posterior crucial ligament, its thick border is connected with the internal lateral ligament, the thin one is free and unattached.

The *external semi-lunar cartilage* forms nearly a complete circle, its two cornua, fixed one before the other behind the spine of the tibia, are so close at their insertion, that they may be said to be interposed between the insertions of the internal semi-lunar cartilage. Its external border is connected behind with the tendon of the popliteus muscle, and in the middle with the external lateral ligament. Towards the front of the joint the inter-articular cartilages are connected by a slight transverse band (*transverse ligament*). Their superior surface is concave, and in apposition with the condyles of the femur, the inferior plane rests on the head of the tibia; both surfaces are invested in nearly their entire extent by the synovial membrane.

180. The *synovial membrane*, like all similar structures, forms a shut sac, whose surface is continuous throughout its entire extent, and as it lines the contiguous surfaces of all the parts entering into the composition of the knee joint, it must necessarily present rather a complex arrangement. This complexity is increased by the existence of a small funnel-shaped fold (improperly named *ligamentum mucosum*) which is stretched across the joint from the lower border of the patella to the margin of the fossa, between the condyles of the femur. It is this process which renders the anatomical arrangement of the synovial membrane so similar to that of the peritonæum and arachnoïd membrane. When tracing its reflexions in order to show its continuity, it becomes necessary to examine them along the median line, which will include the ligamentum mucosum, and then at each side. In order to exhibit the arrangement of the membrane fully, the joint should be laid open by a vertical incision carried along the inner margin of the patella and its ligament, leaving the ligamentum mucosum untouched; after which the inner condyle of the femur, and inner half of the head of the tibia, should be removed by a similar incision, with a saw carried from above downwards. For this purpose the bones should be successively fixed in a vice. A lateral view of the joint being thus obtained, all the parts remaining in their natural position, it will be observed that the membrane is divided into two parts by a transverse funnel-shaped process (*ligamentum mucosum*) the superior one elongated and pyramidal, projects by its summit more than an inch above the patella, its base corresponding with the breadth of the process just named. The inferior division of the membrane is quadrilateral, one side being made up of the lower border of the same process, and the smooth surface of the femur with which it is continuous; another by the articulating surface of the tibia; posteriorly it cor-

responds with the posterior crucial ligament, and anteriorly with the part of the membrane reflected on the ligamentum patellæ.

If we commence at the superior border of the patella to trace the reflexions of the membrane, we find that it lines the articulating surface of that bone, and a little below its inferior border passes directly backwards across the joint, until it reaches the margin of the inter-condyloïd articulating surface, where it is reflected upwards for some way in front of the femur, forming a cul-de-sac between it and the tendon of the extensor muscles, which it lines as it descends again to the patella, whence we began to trace it. The inferior part of the membrane may be traced from the anterior border of the tibia, backwards upon its articulating surface, as far as the insertion of the posterior crucial ligament, upon which it is reflected upwards to the femur, turning forwards upon it until it meets the superior layer of the funnel-shaped process, guided by which it reaches the ligamentum patellæ, and then is reflected downwards to the tibia, whence we started. But for the existence of the transverse funnel-shaped process, the whole outline of the membrane may be traced in the following way, which will answer for each lateral half of it, omitting the part along the median line, in which the process interposes. From the superior border of the patella, it descends, lining its articulating surface; below its inferior border it corresponds with the ligamentum patellæ, from which it is separated by a considerable quantity of adipose matter; on reaching the margin of the tibia, it is reflected over its articulating surfaces, and also on both aspects of the semi-lunar cartilages, giving them a smooth investment; round the crucial ligaments also it forms partial investments, enclosing them as far as their attachments to the femur. The membrane will thus be found to be guided to the articulating surface of that bone at several points, viz. by the two crucial ligaments, by the funnel-shaped process, and by the external margin of the semi-lunar cartilages; from these points it expands over the condyles, and after ascending for some way in front of the femur, (forming a cul-de sac between it and the tendon of the extensor muscles) it passes downwards to the margin of the patella, from which we proceeded to trace its reflexions.

In the enumeration of the ligaments of the knee joint, no mention has been here made of a fibrous capsule, as an investment distinct from the other fibrous structures of the joint. It is not usually described in anatomical demonstrations, and no notice of it occurs in the works of Meckel, Portal, Cloquet, or B. Cooper. A capsular ligament is however attributed to this articulation by Soemmering, Weitbrecht, and Fyfe. The capsular ligament or membrane (membrana capsularis articuli genu) arises in front from the whole circumference of the articulating extremity of the femur, at some distance from its cartilaginous coating, behind from the border of the inter-condyloïd fossa, from which it descends, to be inserted into the rough border which surrounds the head of the tibia. The membrane is also inserted into the margins of the patella and its superior and inferior ligamentous connexions, so that this bone forms part of the capsule of the joint. It is very thin, but is strengthened by the fascia of the limb, and the surrounding aponeurotic structures.

The Peroneo-tibial Articulation.

181. The superior and inferior extremities of the tibia and fibula are connected by ligaments and synovial membranes, and the shafts of the bones are maintained in relation by an interosseous ligament. The contiguous extremities of these bones present superiorly two flat oval surfaces covered with cartilage, which are closely applied to one another, and retained *in situ*, 1, by an *anterior ligament*, which is a broad, flat band of fibres, passing obliquely upwards and inwards, from the head of the fibula to the in-

ternal tuberosity of the tibia; it is covered and strengthened by the tendon of the biceps flexor cruris; 2, by a *posterior ligament* similarly disposed behind the articulation, but stronger and thicker; 3, by a *synovial membrane*, which lines the articulating surfaces of the bones and ligaments.

182. The *interosseous ligament*, which connects the bodies of the tibia and fibula, flat and membranous, is composed of a series of parallel fibres, extended obliquely between the external angle of the tibia, and the ridge on the adjacent surface of the fibula. The direction of the fibres is outwards and downwards; the membrane they compose is broader above than below, and presents in the former situation an elongated opening for the transmission of the anterior tibial vessels, and inferiorly a smaller aperture for the passage of the anterior branch of the peroneal artery.

183. The inferior extremities of the tibia and fibula present two articulating surfaces, of which that of the former is concave, and receives the latter, which is convex, both being covered with cartilage. These are connected by four ligaments and a synovial membrane.

1. The *anterior ligament* is a flat band of fibres, extended obliquely between the heads of the bones, the direction of its fibres being downwards from the tibia to the fibula.

2. The *posterior ligament*, somewhat triangular, is similarly disposed behind the articulation; its external surface is covered by the peronei muscles.

3. The *transverse ligament*, longer but narrower than the former, with which its fibres are closely connected, extends from the head of the fibula to that of the tibia; it forms the posterior boundary of the ankle joint.

4. The *inferior interosseous ligament* consists of some short dense fibres, which connect the heads of the bones, as the great interosseous ligament does their bodies, it can-

not be seen until the anterior and posterior ligaments are removed, and the bones in some degree separated.

The *synovial membrane* lines the articulating surfaces of the tibia and fibula above described, as well as the ligaments which connect them.

The Ankle Joint.

184. The articulation consists of the inferior extremities of the tibia and fibula, united so as to form an arch, into which the superior convex surface of the astragalus is received. Their contiguous surfaces are covered with cartilage, lined by a synovial membrane, and retained in contact by the following ligaments. The *internal lateral ligament* (*ligamentum deltoïdes*) is a broad, flat fasciculus of fibres, one extremity of which is attached to the inferior border of the internal malleolus, the other to the inner side of the astragalus and os calcis. It is broader below than above; its cutaneous surface is covered by the tendon of the tibialis posticus muscle; the articular one is lined by the synovial membrane.

The *external lateral ligament* consists of three distinct fasciculi of fibres, separated by intervals, and disposed in different directions. 1. The central one (*ligamentum fibulæ medium*) descends perpendicularly from the extremity of the fibula, and is inserted into the middle of the external surface of the os calcis. 2. The anterior fasciculus (*ligamentum fibulæ anterius*) passes obliquely forwards from the inferior extremity of the fibula, to the anterior border of the articular surface of the astragalus; it is the shortest of the three. 3. The posterior (*ligamentum fibulæ posterius*), the strongest of the three ligaments, passes obliquely backwards from the extremity of the fibula, towards the posterior surface of the astragalus, where it is inserted into the border of the groove for the tendon of the flexor pollicis longus.

185. At the anterior aspect of the joint is a broad thin

membranous band, composed of irregular fibres, extended obliquely from the border of the articulating surface of the tibia, to the margin of the pulley-like surface of the astragalus. This is usually called the *tibio-tarsal ligament;* it is covered by the tendons of the extensor muscles.

186. The synovial membrane, after having invested the articulating surface of the astragalus, is reflected upwards at each side upon the lateral ligaments, and at the anterior and posterior part of the joint, upon the corresponding fibrous structures, so as to reach the articulating surfaces of the tibia and fibula, by several points at once. These it lines in their entire extent, and also sends upwards between the bones, a process which reaches as far as the inferior interosseous ligament, so that the inferior articulation between these bones, may be said to form part of the ankle joint, as both are lined by the same synovial membrane.

The Articulations of the Foot.

187. The foot is constructed on the principle of an arch, being concave inferiorly, where it rests on the ground, and convex superiorly, where it receives the weight of the body, transmitted to it by the bones of the leg. The posterior extremity, or heel, is narrow, thick, and rounded; the anterior flat, thin, and expanded, being composed of the digital phalanges. The internal border, longer than the external, thick and nearly straight, is composed of the inner border of the calcaneum, the scaphoïd, first cuneïform, and first metatarsal and digital bones of the great toe; the external, shorter and thinner, consists of the calcaneum, the cuboïd, the fifth metatarsal and corresponding digital bones.

The foot being divided into the tarsus, metatarsus, and phalanges, its different parts are respectively bound together by ligaments, and all are united so as to form a whole. The seven bones of which the tarsus consists, may be divided into two sets, the os calcis and astragalus forming the first, the scaphoïd, cuboïd, and three cuneïform bones the second.

188. The astragalus is connected to the os calcis by three ligaments; the chief of which is situated between the bones, and unites them somewhat after the manner that bivalve shells are connected by their muscle. This is termed the *interosseous ligament;* its breadth from side to side is more than an inch; the fibres of which it is composed pass perpendicularly between the bones, one extremity being fixed to the groove between the articulating surfaces of the calcaneum, the other to a corresponding depression in the astragalus. The *posterior ligament* connects the posterior border of the astragalus with the upper surface of the calcaneum; its fibres are oblique, its length and breadth not more than three or four lines. The *external ligament* is a slight fasciculus which descends perpendicularly from the under surface of the astragalus to the external side of the calcaneum; its direction is parallel with the external lateral ligament of the ankle joint. It may be further observed, that as the astragalus is wedged in between the malleoli, and as the lateral ligaments pass downwards from these to the os calcis, they must contribute materially to retain the astragalus in its proper position with regard to the latter bone.

189. The *articulation of the calcaneum with the scaphoïd bone* is effected by means of two ligaments, their surfaces not being in contract. Of these ligaments the inferior one, (*ligamentum calcaneo-scaphoïdeum inferius,* Meckel) much the largest, passes forwards and inwards from the extremity of the calcaneum to the inferior surface of the scaphoïd; its fibres are flat and horizontal, and in contact inferiorly with the tendon of the tibialis anticus muscle, superiorly they form part of the fossa which receives the head of the astragalus. The *external ligament* (*lig. calcaneo-scaphoïdeum externum*) forms the external boundary of the cavity just mentioned; its fibres, very short, are directed from

behind forwards between the contiguous extremities of the bones.

190. The *articulation of the astragalus with the scaphoïd bone.* The astragalus forms with the scaphoïd bone a ball and socket joint. The anterior articulating surface of the calcaneum and the inferior calcaneo-scaphoïd ligament also may be said to enter into this articulation, as all the parts here mentioned are lined by a common synovial membrane. On the dorsum of the foot the astragalus is retained in its situation by the *ligamentum astragalo-scaphoïdeum,* a broad band of fibres extending obliquely forwards from the anterior extremity of the astragalus to the superior surface of the scaphoïd bone; it is covered by the extensor tendons. The necessity for an inferior ligament between these bones is removed by the existence of the calcaneo-scaphoïd ligament. The *synovial membrane* lines the concave surface of the scaphoïd bone, the calcaneo-scaphoïd ligament, and the elongated articulating surface of the calcaneum; from these it is reflected to the under surface of the astragalus and its scaphoïd ligament, and so to the bone of that name from which we began to trace it.

191. The *articulation of the calcaneum with the cuboïd bone.* The connexion between these bones is maintained by three ligaments and a synovial membrane. The *superior calcaneo-cuboïd ligament* is a broad, flat band of fibres, which connects the anterior and superior surface of the calcaneum with the adjacent part of the cuboïd bone. The *inferior* ligament consists of two distinct fasciculi of fibres differing in form and attachments, of which one is superficial, the other deep-seated. The superficial one, called also *ligamentum longum plantæ,* is the longest of the tarsal ligaments. Its fibres attached posteriorly to the inferior surface of the calcaneum pass horizontally forwards, and become intimately connected with the rough tuberosity on the under surface of the cuboïd bone; the greater number of them are continued forwards, and terminate at the base

of the third and fourth metatarsal bones. The *deep-seated calcaneo-cuboïd ligament* lies close to the bones, being separated from the former by some cellular tissue; its breadth is considerable, its length scarcely an inch, one extremity being attached to the calcaneum before the long ligament, the other (somewhat expanded) to the under surface of the cuboïd bone. A synovial membrane lines the surfaces of the two bones, and the ligaments which connect them.

192. The second range of the tarsal bones, viz. the scaphoïd, cuboïd, and three cuneïform, are connected together in the following manner, so as to form separate articulations between each pair of them. The scaphoïd and cuboïd bones when in contact, which is not always the case, present two articulating surfaces covered with cartilage, and lined by a synovial membrane. They are connected by, 1, a *dorsal ligament*, composed of short, thin fibres extended obliquely between the two bones; and, 2, *a plantar*, situated in the sole of the foot, and composed by transverse fibres.

193. The *articulation of the cuboïd with the external cuneïform bone* is effected by a *dorsal* ligament, which is a thin fasciculus of fibres, extended between them, and a *plantar ligament*, whose fibres are transverse.

194. The *articulation of the scaphoïd with the cuneïform bones*. The scaphoïd bone articulates with the three cuneïform, by the smooth faces on its anterior surface, the connexion between them being maintained by dorsal and plantar ligaments. The *dorsal* ligaments, three in number, pass from the superior surface of the scaphoïd to the first, second, and third cuneïform bones into which they are inserted. The *plantar ligaments* are similarly disposed on the under surface of the bones, but not so strongly marked.

195. The three *cuneïform* bones are connected by two dorsal and two plantar ligaments extended transversely from

side to side; the internal one is broader and stronger than the other. The contiguous flat surfaces of the bones are lined by synovial membranes.

196. The *articulation of the tarsus and metatarsus.* The four anterior bones of the tarsus, viz. the three cuneïform and the cuboïd articulate with the metatarsus. The first and third cuneïform bones project beyond the others; so that the anterior extremity of the tarsus is very irregular. The first metatarsal bone articulates with the internal cuneïform; the second is wedged in between the first and third cuneïform; the third metatarsal bone articulates with the extremity of the corresponding cuneïform, and the two last with the cuboïd bone.

197. The five cylindrical bones which form the metatarsus are connected by ligaments, so as to form an integrant part of the foot. At their posterior or tarsal extremity, two sets of ligaments are situated, one on the dorsal, the other on the plantar surface. These consist of three short, thin bands of fibres, which pass transversely across the contiguous extremities of the four last metatarsal bones; the plantar set is similarly disposed; but no such connexion exists between the first and second bones. At the anterior, or digital extremity, the five bones are connected by a *transverse* ligament, which is a flat, thin band of fibres, passing across from the extremity of one bone to the other; it is situated on the plantar surface of the metatarsus.

198. The posterior extremities of the metatarsal bones are retained in contact with the tarsal bones by dorsal and plantar ligaments and synovial membranes. These are flat, thin bands of parallel fibres, which pass from behind forwards, connecting the contiguous extremities of the bones just mentioned. Thus the first metatarsal bone receives a broad, thin band from the corresponding cuneïform bone; the second receives three, which converge to its upper surface, one passing from each cuneïform; the

third has one from the third bone of that name; and finally, the two last are bound by a broad fasciculus to the cuboïd bone. The plantar set is similarly disposed, the first and second are more strongly marked than the corresponding ligaments on the dorsal surface.

199. The anterior extremities of the metatarsal bones are connected with those of the phalanges, by two lateral ligaments, an inferior ligament, and a synovial membrane, similar in every respect to those of the hand. The articulations of the phalanges with one another are also constructed on the same principle as those of the superior extremity.

200. The structures here described enter into the immediate composition of joints; the bursæ mucosæ which surround them may be considered as accessories, as they are placed between parts exposed to much friction, and intended for the same purposes as the synovial membranes, viz. to secrete a fluid, which lubricates contiguous surfaces: their structure and anatomical arrangement are quite similar, both being shut sacs. Bursæ vary considerably in size as well as in form, some being oval or circular, others elongated, so as to form sheaths which enclose tendons. Thus, where tendons are retained *in situ* by fibrous sheaths, the contiguous surfaces are invested by a bursal membrane reflected over them, *ex. gr.* the different flexor and extensor tendons in both extremities; also, where a muscle has to slide over a bony prominence, as where the gluteus maximus passes over the great trochanter, a bursa is interposed; or where processes of bone play on fibrous structures, as between the acromion and the capsule of the shoulder joint. These instances will suffice to point out the operation of the general principle which determines the formation of synovial or mucous bursæ.

CHAPTER IV.

SECTION I.

MUSCLES OF THE ABDOMEN AND LOWER EXTREMITY.

201. WE commence the description of the muscles with those which enter into the composition of the parietes of the abdomen. We may observe *in limine*, that whilst treating of this department of our subject, we shall group the muscles into sets according as they are associated or combined in their more important actions. The abdominal muscles consist of three broad lamellæ on each side, a pair (usually two pair) in front, flat, elongated, and inclosed within the aponeurotic expansions of the former; and another pair situated posteriorly, beside the vertebral column, which are contained within a similar expansion prolonged from the lateral muscles to the lumbar vertebræ.

202. The *obliquus* externus abdominis* (*obliquus descendens; costo-abdominal*, Chaussier; *ilio-pubi-costo-abdominal*, Dumas) is situated on the lateral and anterior parts of the abdomen; its form being broad, thin, and irregularly quadrilateral. It arises from the anterior surfaces of the eight inferior ribs, by fleshy fibres arranged in so many digitations, of which five meet an equal number of similar prolongations from the serratus magnus muscle, and three with those of the latissimus dorsi. The fleshy fibres from the last ribs pass down to be inserted into the external margin of the crista ilei for half its length;

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* The nomenclature of Soemmering has been generally adhered to throughout this part of the work, as being that adopted by the most experienced teachers. Chaussier's terms are added, to facilitate the perusal of French anatomical and surgical works, and those of Dumas merely because they express briefly all the points to which each muscle is attached.

all the rest pass downwards and forwards, and terminate in tendinous fibres, which form a broad aponeurosis, that covers the entire front of the abdomen, and terminates by uniting with that of the corresponding muscle along the median line, from the ensiform cartilage to the symphysis pubis. The inferior fibres of this aponeurosis are closely aggregated together, and extended across from the anterior superior spinous process of the ileum, to the pubis, in the form of a tense band, which is called *Poupart's ligament*. Near the pubis the fibres diverge from one another, leaving between them a triangular interval for the passage of the spermatic cord in the male, and the round ligament in the female. The direction of this interval is upwards and outwards, its base being formed by the crista of the pubis, and the sides by the two sets of diverging fibres, called its *pillars*, of which one is attached to the anterior surface of the symphysis pubis interlacing with the corresponding fibres of the opposite muscle, the other external and inferior is fixed to the spinous process of the pubis, whilst a third portion reflected backwards and outwards, from the latter, is inserted along the pectineal line, being triangular in its form, and nearly horizontal in its direction, and ordinarily denominated *Gimbernat's ligament*. The *direction* of the fibres of this muscle is obliquely downwards and inwards: *structure,* — fleshy, where it is attached to the thorax and ileum, aponeurotic in the rest of its extent: *relations,*—externally with the skin and superficial fascia, internally with the cartilages of the ribs, obliquus internus, rectus, and pyramidalis muscles; posteriorly its free border is covered partly by the latissimus dorsi.

203. The *obliquus internus,* (*obliquus ascendens ; ilio-abdominal,* Chauss.; *ilio-lumbo-costi-abdominal,* Dumas) situated beneath the preceding muscle, is of an irregularly quadrilateral form. It *arises* inferiorly from the iliac half, not unfrequently from two thirds of the inner surface of

Poupart's ligament, from the crista ilei for two thirds of its length, also from an aponeurosis (fascia lumborum) prolonged backwards to the lumbar vertebræ. From these points, the fibres pass with different degrees of obliquity, to be inserted as follows: those from Poupart's ligament arch downwards and inwards, to be fixed into the crista of the pubis, and also for some way into the pectineal line, conjointly with those of the transversalis muscle: or, more strictly, into Gimbernat's ligament, where it is inserted into that line. The fibres, from the anterior part of the crista ilei, pass horizontally inwards, whilst the rest ascend obliquely, and terminate, some in an aponeurosis expanded in front of the abdomen, the rest at the inner margin of the cartilages of the six last ribs, on a plane corresponding with the intercostal muscles. The aponeurosis, on reaching the outer border of the rectus muscle, divides into two lamellæ, one passing before, the other behind it, so as to enclose it in a sheath. *Direction*—obliquely upwards and inwards in the greater part of its extent; some of its fibres are horizontal, the rest are arched downwards: *structure*—fleshy at the sides, aponeurotic anteriorly, and also posteriorly, where it becomes connected with the lumbar vertebræ: *relations*—by one surface with the obliquus externus, by the other with the transversalis; anteriorly with the rectus and pyramidalis, which its aponeurosis serves to inclose, posteriorly with the latissimus dorsi and the deep-seated lumbar muscles.

204. The *cremaster*. Though the cremaster, or suspensory muscle of the testis does not form a part of the abdominal parietes, its description usually follows that of the internal oblique in consequence of the intimate connexion which subsists between them. It is ordinarily said to arise from the inner surface of Poupart's ligament, and from the lower border of the internal oblique muscle, a few fibres also appearing to come from the transversalis; from these origins the fibres pass downwards on the spermatic

cord, and are lost in the tunica vaginalis testis. When examined with attention, the cremaster appears to consist of two fasciculi; the external, and longer, which descends from the lower border of the internal oblique muscle, the other, internal and smaller, being attached to the crista of the pubis. From these points of attachment the fibres descend through the external abdominal ring, converge and unite so as to form arches whose convexity looks downwards, their degrees of obliquity encreasing as they descend. The cremaster does not exist as a distinct muscle before the descent of the testis.* In the fœtus of five months old, the inferior fibres of the internal oblique arch downwards and inwards, from Poupart's ligament to the crista of the pubis, passing over a delicate greyish fasciculus, the gubernaculum testis, which alone occupies the inguinal canal at this period. The gubernaculum is intimately connected with these fibres of the internal oblique, and if it be drawn downwards they may be made to descend through the ring, and if retained in this situation they will strictly resemble the cremaster in direction and attachments. This experiment at once points out the manner in which the cremaster is produced; it shows that the fibres of which it consists were originally part of the inferior oblique muscle, and that, as the testis passes from the abdomen into the scrotum, they are drawn along with it, by reason of the intimate connexion subsisting between them and its gubernaculum. The testis sometimes passes between the fibres of the internal oblique; when this occurs some will lie behind the cord, others (usually the greater number) before it, so that it is completely invested by them.

205. The ***transversalis abdominis***, (*transversus abdominis*, Soemm.; *lombo-abdominal*, Chauss.) situated subjacent to the preceding muscle, and of the same form, arises from the iliac half of Poupart's ligament, from the inner mar-

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* *Recherches Anatomiques sur les Hernies*, par Jules Cloquet.

gin of the crista ilei for two-thirds of its length, from the fascia lumborum, and from the cartilages of the six last ribs. From these different points of origin the fibres pass horizontally forwards, and near the border of the rectus muscle they end in an aponeurosis, which joins with the posterior layer of the internal oblique, and together with it is inserted into the whole length of the linea alba; the inferior fibres curve downwards, and are inserted into the crista of the pubis, and into the pectineal line. This insertion is so intimately connected with that of the internal oblique, that both together have received the name of the conjoined tendon, or aponeurosis, of these muscles: *relations*—externally, with the obliquus internus; internally, with the fascia transversalis, which separates it from the peritonæum: *structure*—muscular at the sides; aponeurotic anteriorly and also posteriorly, where it is prolonged to the vertebral column, forming part of the fascia lumborum.

206. The *rectus abdominis*, (*sterno-pubien*, Chauss.) long and flat, is situated at the fore part of the abdomen, close to the linea alba; it *arises* from the anterior surface of the ensiform cartilage, and its external ligament, also from the cartilages of the sixth and seventh ribs, by separate fleshy points, and is inserted by a strong flat tendon into the crista of the pubis, its fibres being extended perpendicularly between these points. They are however interrupted by tendinous intersections (*lineæ transversæ*) varying in number from three to five. One of these corresponds with the umbilicus, another with the ensiform cartilage, the third intermediate between them; and if a fourth exists, it is placed below the umbilicus. These lines do not usually penetrate the whole substance of the muscle, and some of them extend only half way across it.

The *sheath of the rectus*. This muscle is enclosed in a sheath, which binds it firmly in its situation, and is formed by the aponeuroses of the abdominal muscles, in the following manner: the aponeurosis of the internal oblique on arriving at the external border of the rectus muscle, divides into two lamellæ, of which the anterior one passes in front of the rectus, together with the aponeurosis of the external oblique, whilst the other passes behind it, conjointly with that of the transversalis, becoming again united along the linea alba. This arrangement obtains from the margin of the thorax, as far as to midway between the umbilicus and the pubis, at which point all the aponeuroses pass in front of the rectus, so that the posterior part of its sheath is deficient in the lower third, the muscle being separated from the peritonæum by the fascia transversalis only. The deficiency in the sheath here indicated, is marked by a well defined lunated edge, whose concavity looks downwards towards the pubis.

207. The *pyramidalis,* triangular in its form, and situated close to the linea alba, arises from the crista of the pubis, and becoming narrow as it ascends, is inserted into the linea alba about midway between the umbilicus and pubis; its internal fibres are vertical in their direction, the others more or less oblique. It is covered in front by the aponeuroses of the other muscles, and posteriorly rests on the rectus, of which it may be regarded as an accessory, its more direct action being that of a tensor to the linea alba.

208. The *quadratus lumborum,* (*ilio-costal,* Chauss.) situated deeply in the lumbar region close to the vertebral column, is of an irregularly quadrilateral form. It arises from the crista of the ileum, for about one-fourth of its extent, and is inserted into the inferior border of the last rib, for about half its length, and by four tendinous points into the transverse processes of the four superior lumbar vertebræ. It is enclosed within two lamellæ of the fascia lumborum, forming a sheath for it somewhat similar to that of the rectus, but not so dense or firm in its structure.

209. The *fascia lumborum* may be considered as a membranous prolongation, which passes backwards from the internal oblique and transversalis muscles, to the vertebral

column. It consists of three lamellæ, which are united together at the posterior termination of the fleshy part of the transversalis, from which point the anterior one is continued in front of the quadratus lumborum, and is inserted into the roots of the transverse processes of the lumbar vertebræ, the middle one passes behind that muscle to be attached to the apices of these processes, and the posterior becomes joined to a similar prolongation from the internal oblique, and both are connected to the spinous processes, through the medium of the tendon of the latissimus dorsi. The anterior lamella is immediately subjacent to the peritoneum, and terminates inferiorly at the crista ilei, and superiorly is extended between the last rib and the body of the first lumbar vertebræ, forming the *ligamentum arcuatum,* which shall be described more particularly with the diaphragm.

210. Along the fore part of the abdomen, some linear impressions are traced, which require a special notice, viz. the linea alba, lineæ semi-lunares, and transversæ.

The *linea alba* may be considered as a tendinous cord formed by the juncture of the aponeuroses of the abdominal muscles, and extended perpendicularly downwards from the ensiform cartilage to the pubis. It is covered in front by the common integument; posteriorly, it rests on the fascia transversalis, which separates it from the peritonæum, and on each side it is enclosed by the recti muscles; it is therefore broader above than below, as these muscles diverge from one another in the former situation. In the middle of the linea alba is situated the umbilicus, which in the fœtal state is a foramen for the transmission of the umbilical vein and arteries, but afterwards becomes obliterated.

211. The *lineæ semi-lunares* are two curved lines extending from the cartilages of the eighth rib, on each side, to the tuberosity of the pubis. They thus correspond with the external borders of the recti muscles, (the

enclosed space being broad above and narrow below,) and are formed by the aponeuroses of the internal oblique on each side, as they divide to enclose the recti muscles.

The *lineæ transversæ* have been already noticed with the recti muscles, in the substance of which they are situated.

Combined Actions.—The muscles here described not only enclose and support the abdominal viscera, but by their contractile power are capable of acting successively on them, on the thorax, and on the pelvis. When the pelvis and thorax are fixed, the abdominal muscles can constrict the cavity and compress its viscera, particularly if the diaphragm be made to descend at the same time, as occurs in vomiting, or in the expulsion of the fœtus, of fæces, or urine. If the vertebral column be fixed, these muscles compress the lower border of the thorax, and so contribute to expiration. When it is intended to continue the effort so as to produce a forced expiration, the quadratus lumborum draws down the last rib, and makes it relatively the fixed point to which all the rest are drawn by their inter-costal muscles; but if the vertebral column be not fixed, the thorax may be bent directly forwards, when the muscles of both sides act, or it may be rotated to either side, should they act alternately. Thus if the external oblique of the right side be made to act on the thorax, the first effect appears to be that of drawing its margin down to the pelvis, but if the effort be continued, the trunk will be rotated towards the opposite side. The left internal oblique will co-operate in this action, for the direction of its fibres coincides with that of the right external oblique. The pyramidalis also contributes to the same effect, by rendering the linea alba tense. If the thorax be fixed, the abdominal muscles may be made to act on the pelvis; thus in the action of climbing, the trunk and arms being elevated and fixed, the pelvis is drawn upwards, either directly, or to one side, as a preparatory step to the elevation of the lower limbs. A similar effect may be produced when the trunk is in the horizontal position, for the pelvis may be drawn forward and flexed upon the vertebral column, by the recti and pyramidales.

Muscles of the anterior and inner part of the Thigh.

212. The *sartorius* (*ilio-pretebial*, Chauss.; *ilio-creti tibial*, Dumas) is situated at the anterior and inner aspect of the thigh; its form elongated, flat, and riband-shaped, being the longest muscle in the body. It *arises* from the curved margin of the ileum, between its anterior superior, and inferior spinous processes, and slightly from the former point of bone, and is *inserted* by an expanded aponeurosis into the spine of the tibia, just below its tuberosity. *Direction*—obliquely downwards and inwards in the upper third of its extent, then vertical as far as the knee, where it turns horizontally forwards to its point of attachment: *structure*—fleshy, except at the extremities, which are tendinous. The inferior tendon broad and expanded, covers those of the gracilis and semi-tendinosus, and sends off an expansion which strengthens the fascia of the leg, by becoming identified with it. *Relations*—by the anterior surface with the fascia lata; by the posterior, with the iliacus, psoas, and rectus femoris muscles, the femoral vessels, the adductor longus, adductor magnus, vastus internus, gracilis, and semi-tendinosus muscles. Its internal border bounds with the adductor longus, a triangular space, through the centre and apex of which the femoral artery passes.

213. The *rectus femoris* (*droit anterieur crural*, Bichat; *ilio-rotulien*, Chauss., Dumas) is situated in front of the thigh, being extended in a straight line from the pelvis to the patella. *Form*—elongated, smaller at the extremities than in the middle. It *arises* by two tendons, one of which embraces the anterior inferior spinous process of the ileum, the other, reflected outwards, is attached along the brim of the acetabulum; from their union the muscle descends to be *inserted* into the patella, in conjunction with the triceps extensor. *Direction*—vertical: *structure*—fleshy, except at the extremities, which are tendinous: *relations*—the anterior surface is covered in all its extent by the fascia lata, except a small portion superiorly, where it is separated from it by

the iliacus and sartorius muscles (the reflected tendon is covered by the gluteus minimus); by the posterior surface it is in relation with the fibrous capsule of the hip joint, and triceps extensor muscle.

214. The *triceps extensor cruris* (*crural*, Bichat; *tri-femoro-rotulien*, Chauss.; *tri-femoro-tibi-rotulien*, Dumas) encircles all the body of the femur, except the linea aspera, and the spaces between its bifurcations. Superiorly, it is divided into three portions or heads, whence its name; inferiorly, they are attached by a common tendon to the patella, which we shall consider as their common origin. This tendon, at first confounded with that of the rectus muscle, soon separates from it, and ascending a little way on the femur, gives off three processes, corresponding with the three divisions of the muscle, viz. the vastus externus, the vastus internus, and crureus; from the tendon moreover, a fascia or aponeurosis is sent down over the knee joint, which strengthens the articulation, and is inserted into the head of the tibia. Each of these parts of the triceps is usually described as a distinct muscle.

1. The *vastus externus* is situated on the outside of the femur, larger above and in the centre than below; its fleshy fibres *arise* from the outer side of the common tendon, and pass to their insertion with varying degrees of obliquity. The inferior fibres pass almost transversely outwards, to about the middle of the line, leading from the outer condyle of the femur to the linea aspera, those higher up are inserted into the external margin of the linea aspera and its superior bifurcation, the rest are implanted into the external surface of the bone, as far as the base of the great trochanter. *Direction*—the lower fibres are transverse, the rest oblique: *structure*—aponeurotic and fleshy: *relations*—anteriorly, with the fascia lata, posteriorly, with the femur; its external border is in apposition with the short head of the biceps and gluteus maximus; the internal with the crureus, with whose structure it is identified.

215. 2. The *vastus internus* is situated on the inner side

of the femur. *Form*—elongated, broader below than above. It *arises* from the inner side of the common tendon, from which its fibres, like those of the preceding muscle, pass obliquely to their insertion; the inferior fibres terminate above the middle of the oblique line, leading from the inner condyle to the linea aspera; those higher up are implanted into the inner margin of the linea aspera itself, the rest being inserted into the surface of the bone, as far as the base of the lesser trochanter. *Direction*—the lower fibres run almost transversely; the rest obliquely, upwards and inwards: *structure*—aponeurotic and fleshy: *relations*—by its anterior and inner surface, with the fascia lata, the sartorius, and femoral vessels; the posterior surface rests on the femur; the inner border is in contact with the adductor magnus, longus, pectineus, and psoas muscles, the external is blended with the crureus.

216. 3. The *crureus* is situated on the anterior surface of the femur, between the two vasti, with which it is intimately blended. It *arises* from the centre of the common tendon, which is prolonged for some way upon its forepart; its fleshy fibres are inserted into the upper three-fourths of the anterior surface of the femur, ceasing at the anterior inter-trochanteric line. *Direction*—vertical: *structure*—tendinous and fleshy: *relations*—its anterior surface is covered by the rectus, the posterior rests on the femur, its two borders being blended with the vasti.

Combined Actions.—The rectus, vasti, and crureus, are named by Soemmering quadriceps extensor, their intimate union and similarity of action being sufficient reasons for considering them as a single muscle, consisting of four parts. The most ordinary action of these muscles is to extend the leg upon the thigh, which they are enabled to do by their connexion with the patella and its ligament, the latter being inserted into the tibia. The leg, however, may be somewhat bent upon the thigh, and drawn a little inwards towards the opposite limb, by the sartorius. If the leg be fixed, as in the standing posture, the extensor muscles taking their fixed point below, will act upon the femur and keep it perpendicularly on the condyles of the tibia, so as to counteract the influence of the weight of the body, which tends to flex the knee as well as the other articulations. The rectus and sartorius assist materially in maintaining the erect position of the body, for instance, when we stand on both legs, for they act on the pelvis and draw it forwards, so as to keep it fixed and upright on the femur; in this they become assistants to the psoas and iliacus. It may be observed that the oblique direction of the sartorius enables it to give a slight rotatory motion to the pelvis, when we stand on one leg, by drawing the spinous process downwards and inwards.

217. The *pectineus* (*pectinalis*, Douglas; *sus-pubio-femoral*, Chauss.; *pubio-femoral*, Dumas) is situated at the superior and fore-part of the thigh. *Form*—flat and nearly triangular. It *arises* from the ileo-pectineal line between the eminence of the same name, and the spine of the pubis, and is *inserted* into the line which connects the smaller trochanter to the linea aspera of the femur, immediately below the united attachment of the psoas and iliacus muscles. *Direction*—downwards, outwards, and backwards; opposite the smaller trochanter it turns on itself, so that the anterior surface looks somewhat outwards: *structure*—fleshy, except at the attachments, which are aponeurotic: *relations*—by the anterior surface, with the fascia lata and femoral vessels; by the posterior surface, with the obturator vessels and nerves, and the external obturator and adductor brevis muscles; by the outer border with the psoas magnus, by the inner border, with the adductor longus.

218. The *gracilis* (*droit interne crural*, Bichat; *sous-pubio-pretibial*, Chauss.) is situated along the inner border of the thigh. *Form*—elongated, slender, broader at the upper than at the lower extremity. It *arises* from the body of the pubis, close to its symphysis (the lower half of its depth) also from the border of its ramus, and is *inserted* into the

inner side of the tuberosity of the tibia on the same plane with the semi-tendinosus, and under the expanded tendon of the sartorius. *Direction*—vertical; at the lower extremity it inclines forwards to the point of attachment: *structure*, aponeurotic superiorly, tendinous in the inferior third, and fleshy in the rest of its extent: *relations*—its inner surface is covered by the fascia lata, except a small part inferiorly, which is separated from it by the sartorius; the external rests against the adductor longus, magnus, and semi-membranosus, the knee joint, and its internal lateral ligament.

219. The *adductor longus* (*adductor primus*, Douglas; *moyen adducteur*, Bichat; *pubio-femoral*, Chauss; *spini-pubio-femoral*, Dumas) is situated at the superior and inner part of the thigh. *Form*—flat and irregularly triangular. It *arises* from the external surface of the angle of the pubis, between its spine and symphysis, and is *inserted* into the middle third of the linea aspera, between the vastus internus, and adductor magnus. *Direction*—downwards, outwards, and backwards: *structure*—tendinous at its origin, fleshy in the middle, aponeurotic inferiorly. From the aponeurosis several fibres are detached, which unite with those of the adductor magnus: *relations*—its anterior surface is covered by the fascia lata, sartorius, and crural vessels; the posterior rests on the two other adductor muscles. The external border is parallel with the pectineus, (a small portion of the adductor brevis being observable behind and between them), the inner border, which is much the longest, is in apposition with the gracilis.

220. The *adductor brevis* (*adductor secundus*, Douglas; *petit adducteur*, Bichat; *sous-pubio-femoral*, Chauss.; Dumas) is situated at the upper and inner part of the thigh. *Form*—nearly triangular, compressed above, from side to side, below from before backwards. It *arises* by a narrow origin, beneath the preceding muscle, from the external surface of the pubis, and is *inserted* into the oblique line leading from

the base of the lesser trochanter to the linea aspera, immediately behind the insertion of the pectineus. *Direction*—the same as the adductor longus: *structure*—fleshy, except at its attachments, which are aponeurotic: *relations*—by the anterior surface with the pectineus, and adductor longus; by the posterior, with the adductor magnus; by the external border with the obturator externus, and the tendon of the psoas and iliacus; by the inner border, with the gracilis, in part of its extent, the rest being concealed between the two other adductors. This muscle is pierced by some of the perforating branches of the profunda artery.

221. The *adductor magnus* (*grand adducteur*, Bichat; *ischio-femoral*, Chauss.; *ischio-pubio-femoral*, Dumas) is situated at the posterior and inner part of the thigh; it *arises* from the ramus of the pubis, and that of the ischium, also from the border of the tuberosity of the latter bone. The muscular fibres diverge from their origin, somewhat like the ribs of a fan from their central pivot, those from the pubis, shorter than the rest, pass transversely outwards, and are inserted into the rough line prolonged from the linea aspera to the linea quadrata; others pass with varying degrees of obliquity downwards and outwards, to be inserted into the whole length of the linea aspera, and a small part of its internal bifurcation, where they end in a pointed process; finally, some of the fibres descend almost vertically, forming the inner border of the muscle, and terminate in a rounded tendon, which is inserted into the tuberosity on the inner condyle of the femur. The muscle thus presents two parts, one a flat broad plane, inserted into the linea aspera, and forming a septum between the anterior and posterior muscles of the thigh; the other being the elongated part which goes to the condyle. Between these an angular interval is left for the transmission of the femoral vessels backwards into the popliteal space. *Direction*—the fibres pass obliquely from

within, outwards and downwards, radiating as from a common centre: *structure*—fleshy in the greater part of its extent, aponeurotic where it arises from the ischium, and is inserted into the condyle: *relations*—the superior, or shortest border, is parallel, and on the same plane with the quadratus femoris; the internal, or longest border, is covered by the fascia lata, gracilis, and sartorius; the external border (its femoral attachment), is interposed between the two other adductors and the vastus internus, which lie in front of it, and the gluteus maximus, and short head of the biceps, which separate it from the vastus externus. The posterior surface is covered by the sciatic nerve and ham-string muscles, the anterior by the sartorius, the adductor brevis and longus, and the crural vessels. The anterior surface of the muscle is intimately blended with the adductor longus before they reach their insertion, it also sends off an aponeurosis, which passes in front of the femoral vessels, and becomes blended with the vastus internus; finally its prolonged portion is intimately connected with the last named muscle. The interval left between the two parts of this muscle for the passage of the femoral vessels, is triangular in its form, and fleshy and tendinous in its structure, when viewed from behind, but at its anterior aspect it is altogether tendinous in its entire extent, and oval in its form, its margins being formed of the following parts; viz., the prolonged tendon of the adductor magnus internally, the vastus internus externally, the superior border corresponding with the conjunction of the adductor longus and magnus; the inferior with the point of union between the prolonged tendon of the last named muscle and the vastus internus.

Combined Actions.—These are the direct adductors of the femur, and their force must be considerable, both from their strength and number. As the linea aspera projects from the shaft of the bone, the adductors are removed proportionally from its axis, and so are enabled to rotate it outwards, thus conspiring with a distinct class of muscles, the external rotators. If the whole limb be in the extended position, they will draw it inwards, the gracilis materially assisting. The femur is bent on the pelvis by the action of the pectineus, together with the adductor longus and brevis, thus conspiring with the psoas and iliacus. When the lower extremities are firmly fixed on the ground, these muscles contribute to maintain the body in the erect position, by taking their fixed point below, and thence acting on the pelvis. If this effort be continued, the pectineus and adductor longus may be made to flex the pelvis on the femur, by drawing the pubis downwards.

222. The *psoas magnus* (*prelombo-trochantinien*, Chauss.) is situated along the side of the lumbar vertebræ, the margin of the pelvis, and deeply at the superior part of the thigh. *Form*—thick and round at the centre, diminishing in size towards the extremities. It *arises* from the side of the body of the last dorsal vertebra, and of the four first lumbar, also from the transverse processes of the latter. From these attachments, which are separated by the branches of the lumbar plexus of nerves, the muscle passes across the brim of the pelvis, and beneath Poupart's ligament, and ends in a tendon, which is inserted into the lesser trochanter. *Direction*—vertical: *structure*—fleshy in the centre, tendinous at its insertion: *relations*—vary in the different parts of its extent; its posterior surface corresponds above with the vertebræ, and their transverse processes, in the middle—with the margin of the pelvis, farther down with the pubis, and capsular ligament of the hip joint; the anterior surface placed behind the peritonæum, is in relation above with the ligamentum arcuatum and diaphragm, the renal vessels, the ureter, the vena cava on the right side, the aorta on the left; in the middle it is covered by the iliac fascia, farther down by the femoral artery, which rests upon it; and finally, by the deep seated vessels of the groin, inguinal glands, &c. In the pelvic region, the inner border is in contact with the iliac artery, the external, with the crural nerve.

223. The *psoas parvus* (*prelombo-pubien*, Chauss.) is situated (when it exists, which is not always the case) along the inner side of the psoas magnus. *Form*—long and thin. It *arises* from the body of the last dorsal and first lumbar vertebræ, and soon ends in a flat tendon, which passes along the anterior and inner side of the psoas magnus, to be inserted into the ileo-pectineal eminence. *Direction*—vertical: *structure*—muscular and tendinous: *relations*—resting on the psoas magnus in the whole of its extent, it is covered by the fascia iliaca, the iliac and renal vessels, and at its origin by the diaphragm.

224. The *iliacus* (*iliacus internus*, Albinus. Soemm.; *ilio-trochantinien*, Chauss.) is situated in the iliac fossa, which it fills up. *Form*—flat and somewhat radiated. It *arises* from the upper two-thirds of the iliac fossa, from the anterior two-thirds of the inner margin of the crista ilei as far as its two spinous processes, and posteriorly from the ileo-lumbar ligament. From these different origins, the fibres pass down, the greater number inclining obliquely inwards, to be inserted into the tendon common to this muscle, and the psoas magnus, some of them being prolonged into the oblique line which leads downwards from the lesser trochanter: *structure*—fleshy in almost all of its extent: *relations*—posteriorly with the ileum, and capsular ligament of the hip joint, anteriorly with the iliac fascia and anterior crural nerve, which separate it from the peritonæum, with the cœcum at the right side, and with the sigmoïd flexure of the colon on the left.

Combined Actions.—The psoas and iliacus, when they take their fixed point above, can bend the thigh on the pelvis, and rotate the limb somewhat outwards; the latter power being derived from the mechanical advantage given them by the projection of the trochanter minor. These muscles assist materially in maintaining the erect position of the body, in which case they take their fixed point at their insertion into the femur, and then act upon the pelvis and spinal column, drawing them forwards so as to keep them erect upon the thighs. If this action be continued, the trunk may be bent forwards as in bowing. It is scarcely necessary to add, that this bending of the body will be directly forwards, if the muscles of opposite sides act together, and obliquely to one side, if they act separately.

225. The *tensor vaginæ femoris* (*ilio-aponevrosi-femoral*, Chauss.; Dumas) is situated at the superior and external part of the thigh. *Form*—elongated and flat, broader at the lower than at the upper extremity. It *arises* from the external surface of the anterior superior spinous process of the ileum, between the gluteus medius and sartorius, and terminates about two inches below the great trochanter of the femur, its fleshy fibres being received between two laminæ of the fascia lata, into which they are thus inserted. *Direction*—downwards and outwards: *structure*—aponeurotic in its origin, fleshy in the rest of its extent: *relations*—its external surface is covered by a layer of the fascia lata; the internal is also embraced by another process of the same membrane, which separates it from the rectus femoris and the vastus externus.

Action.—As its name imports, the direct action of the muscle is to render the fascia tense, and so assist the other muscles. If this effort be farther continued, the obliquity of its direction will enable it to rotate the whole limb inwards, provided the other muscles remain quiescent; if the extensor muscles conspire to keep the limb in the straight position, the tensor can only act as an assistant to the abductors. In the erect position, by taking its fixed point below, it will act on the pelvis.

Muscles on the posterior part of the Pelvis.

226. The *gluteus maximus* (*sacro-femoral*, Chauss.; *ilii-sacro-femoral*, Dumas) is situated at the nates, the prominence of which it forms. *Form*—broad, thick, and irregularly quadrilateral. It *arises*, 1, from the posterior fifth of the crista of the ileum, and the irregular rough surface subjacent to that part; 2, from the posterior surface of the sacrum below the ileum, and from the side of the coccyx in

its whole length; 3, from the posterior sciatic ligament. From these origins, the coarse thick fibres of which the muscle consists, converge as they pass downwards and outwards, and terminate in a broad strong tendon, whose external surface is rough and irregular, but the internal is smooth, and lined by a bursa mucosa, where it corresponds with the great trochanter. This tendon is *inserted* between the vastus externus and adductor magnus, into that rough longitudinal impression which descends from the great trochanter to the linea aspera. *Direction*—downwards, forwards, and outwards: *structure*—the fleshy fibres, which immediately succeed to the aponeurosis of attachment superiorly, are arranged in parallel lines and aggregated into large distinct bundles, separated by cellular membrane. These fleshy bundles successively terminate at the posterior border of a strong, common tendon, which extends from opposite the upper part of the great trochanter, where it is broad, and confounded with the fascia lata, to the line of attachment just described: *relations*—when the muscle is separated from its superior connexions and reflected downwards, it will be found that its inner surface covers, and is therefore in relation with the ileum, sacrum, and coccyx, the great sciatic ligament, gluteus medius, the gluteal, sciatic, and pudic arteries, the external rotator muscles, the great sciatic nerve, the trochanter major, the tuberosity of the ischium, and the superior extremities of the semi-tendinosus, and biceps muscles; its external surface is covered by the fascia lata; the upper and anterior border is firmly connected by that membrane with the gluteus medius; the posterior is on the same plane, and somewhat identified with the common origin of the sacro-lumbalis, and longissimus dorsi muscles, the inferior border (the longest) forms the fold of the nates.

227. The *gluteus medius*, (*grand ilio-trochanterien*, Chauss.; *ilio-trochanterien*, Dumas) is situated on the external surface of the pelvis, partly covered by the preceding

muscle, partly sub-cutaneous. It *arises* from all that space on the outer surface of the ileum, which is inclosed between the external margin of its crista and the semi-circular line extended between the anterior superior spine and the sacro-sciatic notch. From this extensive origin the fleshy fibres as they descend converge to a short thick tendon, which is blended anteriorly with that of the gluteus minimus, and posteriorly in many instances with the pyriformis, after which its fibres are inserted into the broad external surface of the trochanter major, and somewhat into its upper border. *Direction*—the anterior fibres extend obliquely backwards, the posterior obliquely forwards, the middle perpendicularly: *structure*—tendinous at the inferior attachment, fleshy in the rest of its extent: *relations*—part of the external surface is covered by the gluteus maximus, the rest by the fascia lata; the inner surface rests on the ileum and gluteus minimus; the posterior border is in relation with the pyriformis muscle and the gluteal vessels; the anterior is intimately connected with the tensor vaginæ femoris, by means of the fascia lata.

228. The *gluteus minimus*, (*petit ilio-trochanterien*, Chauss.; *ilio-ischii-trochanterien*, Dumas) is situated on the inferior part of the dorsum ilei. *Form*—radiated, broad above, narrow below. It *arises* from all that space on the dorsum ilei between the superior curved line and the inferior one, which extends immediately above the brim of the acetabulum. From this origin the fibres converge as they descend, and end in a short tendon, which is *inserted* into the anterior border, and somewhat into the external surface of the great trochanter, where they are blended with those of the gluteus medius. *Direction*—the middle fibres are vertical, the anterior are inclined backwards, the posterior forwards, converging to the common tendon: *structure*—fleshy in the greater part of its extent, tendinous at its insertion: *relations*—by its external surface with the gluteus medius; by the internal with the dorsum ilei, with

the external tendon of the rectus femoris, and with the fibrous capsule of the hip joint to which it intimately adheres.

Combined Actions.—The glutei act alternately on the femur and pelvis, according as the one or the other becomes relatively their fixed point of attachment. All three act as abductors; the anterior fibres of the medius and minimus draw the trochanter forwards, the posterior backwards, giving it a slight rotatory motion. The maximus is a powerful abductor; and by the direction of its fibres is calculated to draw the femur backwards, at the same time that it rotates the whole limb outwards if it be kept extended. When the thighs become the fixed points, these muscles act on the pelvis. The great glutei draw it backwards and maintain it and the body in the erect position; in this they are assisted by the semi-tendinosus, semi-membranosus, and biceps of each side, which act on the tuberosities of the ischia, and draw them downwards, so as to elevate the fore part of the pelvis. The gluteus medius and minimus are chiefly called into action in progression, and in standing on one leg; they draw the pelvis towards the femur, which is fixed, and by this action counterbalance the weight of the trunk, and maintain it erect on the limb. This alternation of action of the muscles of opposite sides during progression, gives to the pelvis that rotatory motion so perceptible in those who walk irregularly, and do not, as the phrase is, " keep the step," but is strikingly evident in females, in consequence of the great breadth of the pelvis.

229. The *pyriformis*, (*le pyramidal*, Winslow; Bichat; *sacro-trochanterien*, Chauss.; *sacro-ilei-trochanterien*, Dumas) is situated at first within the pelvis, and afterwards on its posterior and external surface. *Form*—elongated, as its name imports. It *arises* by three fleshy and tendinous digitations, from the second, third, and fourth divisions of the sacrum, interposed as it were between the sacral foramina; a few fibres are also connected with the inner surface of the ileum. From these attachments the muscle passes out of the pelvis by the great sciatic notch, and is *inserted* into the

summit of the great trochanter by a rounded tendon, whose fibres are blended somewhat with those of the gluteus medius. *Direction*—downwards and outwards: *structure*—fleshy and tendinous: *relations*—within the pelvis it is placed behind the sciatic plexus of nerves, the internal iliac vessels, and the rectum (the last more especially at the left side). Outside the pelvis one surface rests on the ischium and the fibrous capsule of the hip joint, the other is covered by the gluteus maximus; its superior border is parallel with the gluteus medius, from which it is separated by the gluteal vessels as they emerge from the pelvis, the inferior with the gemellus superior and the sciatic nerve.

230. The *gemelli* (*ischio-trochanterien*, Chauss.; *ischio-spino-trochanterien*, Dumas) situated at the posterior and external part of the pelvis, are two in number, and named from their position superior and inferior, the latter being the larger. The superior one *arises* from the spinous process of the ischium, the inferior from the upper and back part of the tuberosity of that bone, and both are *inserted* into the digital or trochanteric fossa, together with the tendon of the obturator internus, which they enclose and almost conceal. *Direction*—transverse: *structure*—tendinous at their insertion, fleshy in the rest of their extent: *relations*—their posterior surface is covered by the sciatic nerve and gluteus maximus muscle, the anterior surface rests on the ischium and fibrous capsule of the hip joint, the smaller gemellus corresponds by its upper border with the pyriformis, the larger by its lower border with the tendon of the obturator externus, the contiguous borders of each being intimately connected with the tendon of the obturator internus which runs between them.

231. The *obturator internus*, (*sous-pubio-trochanterien* Chauss.; *intra-pelvio-trochanterien*, Dumas) is situated chiefly within the pelvis, a small part only being placed on its external surface. *Form*—flat and triangular. It *arises* by tendinous and fleshy fibres, from the inner flat surface of

the os pubis, extending from near its symphysis as far as the margin of the obturator foramen, from the obturator membrane, except where it is pierced for the transmission of the obturator vessels, and from the inner flat surface of the ischium as far back as the sciatic notch, on a level with a line drawn from the upper margin of the obturator foramen, backwards to that of the notch. The fibres converge to a tendon which passes out of the pelvis by the inferior sciatic notch, and is inserted into the trochanteric fossa between the gemelli muscles. *Direction*—it at first passes backwards, then is reflected over a pulley-like surface on the ischium, situated between the spine and tuberosity of that bone, after which it proceeds horizontally outwards, so that the internal and external portions form a considerable angle with one another: *structure*—fleshy, whilst within the pelvis; its tendon flat and uniform on its posterior surface presents at its anterior aspect four small tendinous bundles, which slide in separate grooves on the surface of the ischium: *relations*—within the pelvis it is covered by the internal pudic artery and obturator fascia, which separates it from the levator ani muscle, its tendon lies on the ischium and fibrous capsule of the hip joint, being covered by the great sciatic nerve and gluteus maximus muscle; its borders are enclosed between the gemelli.

232. The *quadratus femoris* (*ischio-sous-trochanterien*, Chauss.; *tuber-ischio-trochanterien*, Dumas) is situated at the posterior and superior part of the thigh. *Form*—an oblong square. It *arises* from the external curved border of the tuber ischii, and is *inserted* into the lower half of the posterior border of the great trochanter; its middle corresponding with a smooth rising or tuberosity observable in that border. The line of insertion of this muscle may probably be called *linea quadrata*, to distinguish it from the inter-trochanteric line, the latter being oblique in its direction, the former vertical. *Direction*—horizontally outwards: *structure*—slightly tendinous at its attachments, fleshy in

the rest of its extent: *relations*—by its posterior surface with the sciatic nerve, the gluteus maximus, and semi-membranosus muscles; by the anterior, with the obturator externus, the lesser trochanter, and part of the insertion of the psoas magnus muscle; its upper border is in relation with the inferior gemellus, the lower with the adductor magnus.

233. The *obturator externus*, (*sous-pubio trochanterien externe*, Chauss.; *extra-pelvio-pubi-trochanterien*, Dumas) is situated on the anterior and external aspect of the pelvis, and superior part of the thigh. *Form*—flat and triangular. It *arises* from the external flat surface of the os pubis, from the rami of the pubis and ischium, as far as the margin of the obturator foramen, and from about half the surface of the obturator membrane. From this extensive origin the fibres pass outwards, converging to a tendon, which is directed behind the neck of the femur, to be *inserted* into the lower part of the trochanteric fossa, beneath the inferior gemellus: *direction*—obliquely outwards, winding round the posterior part of the neck of the femur: *structure*—tendinous at its insertion, fleshy in the greater part of its extent, with a slight mixture of aponeurotic fibres at its origin: *relations*—its anterior surface, which in the erect position of the body, is also the inferior one, is covered by the adductor brevis, and pectineus muscles, also by the obturator vessels; the posterior one corresponds with the os pubis, its ramus, and that of the ischium, as well as the obturator membrane; one surface of its tendon is closely connected with the fibrous capsule of the hip joint, the other is covered by the quadratus femoris.

Combined Actions.—The transverse direction of these muscles and their mode of insertion into the trochanter, together with the great mechanical advantage afforded them by the length of the cervix femoris, enables them to act powerfully in rotating the thigh, and therefore the whole limb outwards. In position, direction, and action, they are analogous to the muscles which pass from the dorsum of the scapula, to the great tuberosity of the humerus;

the latter, however, are equalled in strength by their antagonist, the sub-scapularis, but the external rotators of the thigh are very feebly opposed by the tensor vaginæ femoris, and the anterior fibres of the gluteus medius which alone act directly in rotating the limb inwards, if we except the semi-tendinosus, which may, under some circumstances, co-operate in this action. If the femur be bent on the pelvis, the line of direction of these muscles, nearly coincides with the axis of the bone; their power of rotation then ceases, and they become to a certain extent abductors. This is particularly observable in the pyriformis, both from its direction and point of insertion.

Muscles on the posterior part of the Thigh.

234. The *bicepsfemoris*, (*ischio-femoro-peronier*, Chauss.; Dumas) is situated at the posterior part of the thigh. *Form*—elongated, divided above into two portions, or heads, of which one, the ischiatic, is long and round; the other, the femoral, flat, and somewhat shorter. The long head *arises* by a tendon common to it and the semi-tendinosus, from the posterior and outer part of the tuberosity of the ischium, the femoral portion (or short head) from the linea aspera of the femur, as high up as the insertion of the gluteus maximus, between the adductor magnus, and vastus externus muscle. These two parts having united and become tendinous, are *inserted* into the head of the fibula: the tendon whilst being attached, separates into two portions, which embrace the external lateral ligament of the knee joint. One of these passes forwards upon the articulation of the fibula with the tibia, from the other an expansion is given off, which strengthens the fascia of the leg. *Direction*—vertical: *relations*—posteriorly with the gluteus maximus, and fascia lata, in front with the semi-membranosus muscle, the sciatic nerve, and adductor magnus; inferiorly with the gastrocnemius externus and external articular arteries.

235. The *semi-tendinosus* (*ischio-pretibial*, Chauss.) is situated at the posterior and inner part of the thigh.

Form—elongated. It *arises* from the posterior part of the tuber ischii, close to the inner side of the biceps, and continues to arise from the tendon of that muscle for three inches lower down, somewhat in the same way as the coraco brachialis does from the biceps of the arm. A little below the middle of the thigh it ends in a long round tendon, which passing along the inner side of the popliteal space, is reflected forwards, to be inserted into the inside of the upper part of the tibia, about two inches below its tuberosity, where the tendon is on the same plane, and beneath that of the gracilis. *Direction*—nearly vertical: *structure*—as its name implies, fleshy in half its extent, tendinous in the rest: *relations*—its posterior surface, except where it is slightly overlapped by the biceps, is covered by the fascia lata, the anterior surface rests on the semimembranosus in part of its extent, the adductor magnus in the rest, its insertion is covered by that of the sartorius.

236. The *semi-membranosus*, (*ischio-popliti-tibial*, Chauss.) is situated obliquely at the posterior and inner part of the thigh. It *arises* from the posterior part of the tuberosity of the ischium, in front of the biceps and semitendinosus, and behind the quadratus femoris, and is inserted by three portions, of which the middle one is fixed to the tibia, behind its inner tuberosity, and sends an expansion which covers the popliteus muscle, the internal portion passes forwards under the internal lateral ligament, and is inserted along the side of the inner tuberosity of the femur; the third, broad and expanded, is reflected backwards and upwards behind the joint, and is inserted into the external condyle of the femur, becoming identified with the ligamentum posticum. *Direction*—nearly vertical: *structure*—fleshy in the middle, tendinous at its extremities: *relations*—by the posterior surface with the biceps, semi-membranosus and fascia lata; by the anterior surface with the quadratus femoris, adductor magnus, the popliteal artery, inner head of the gastrocnemius and knee joint, by the inner border with

the gracilis and fascia lata, by the outer border with the sciatic nerve.

Combined Actions.—These are usually called the ham-string muscles, as they enclose the ham, or space at the posterior aspect of the knee joint; the biceps being placed at its external side, the other two at the internal. Their direct action is that of flexing the leg on the thigh, and this they do directly backwards, when they conspire in their action, but if they be made to act alternately, the leg will be rotated slightly inwards or outwards; the latter motion, however, can only take place in the semi-flexed position of the limb. In the standing posture, these muscles, by taking their fixed point below, will act on the pelvis so as to prevent its flexion forwards, and if the effort be continued, they will draw it directly backwards, and commence that series of muscular actions observable in tumbling, and other feats of activity, in which the body is thrown backwards so as to form an inverted arch.

Muscles on the anterior and external part of the Leg.

237. The *tibialis anticus* (*tibio-sus-tarsien*, Chauss.) is situated at the front of the leg. *Form*—elongated, thicker above than below. It *arises* from the external tuberosity of the tibia, and from about two-thirds of the flat surface beneath it, from a small portion of the interosseous ligament, from the fascia of the leg, and an aponeurotic septum separating it from the extensor digitorum communis muscle, and is *inserted* into the internal surface of the first cuneïform bone, and the contiguous extremity of the first metatarsal bone: *direction*—downwards, and a little inwards: *structure*—fleshy in the two upper thirds, tendinous in the lower: *relations*—the upper, or fleshy portion, corresponds in front, with the fascia of the leg, to which it is adherent behind with the interosseous ligament, on the fibular side with the extensor digitorum communis, and extensor proprius pollicis, from which it is partly separated by the anterior tibial vessels. The tendon crosses obliquely in front of the lower end of the tibia, the ankle joint, and the an-

surface of the calcaneum, and from the ligament connecting that bone with the astragalus, and terminates in four tendons, the first, or most internal of which, is inserted into the tarsal end of the first phalanx of the great toe, the other three become severally united to the outer border of the extensor tendons, proceeding to the three next toes: *structure*—fleshy and tendinous: *relations*—it is covered by the tendons of the long extensor and peroneus tertius, and rests on the tarsus, metatarsus, and the dorsal interosseous muscles.

Combined Actions.—A very slight effort of the extensor communis and proprius pollicis, extends the digital phalanges, and if their action be continued, they will be made to bend the foot upon the leg. This they are enabled to do by the manner in which their line of direction is altered by the annular ligament of the ankle joint, as it gives them all the mechanical advantage of a pulley. The tibialis anticus, and the peroneus tertius, are the direct flexors of the foot on the leg, and if either acts separately, it will give it a slight inclination towards the corresponding side. In the erect position these muscles take their fixed point below, and by drawing on the bones of the leg, keep them perpendicular on the foot. The extensor brevis is obviously but an accessory to the long extensor; but from the obliquity of its direction, it is fitted not only to extend the toes, but also to draw them somewhat outwards.

242. The *peroneus longus* (*peroneo-sous-tarsien*, Chauss.) is situated at the outer side of the leg, and under the foot. *Form*—very long and narrow, reflected on itself inferiorly. It *arises* from the upper third of the anterior surface of the fibula, and forms a small part of the external tuberosity of the tibia, from aponeuroses separating it on the inner side from the extensor digitorum communis, on the outer side from the soleus and flexor longus pollicis muscles, and from the fascia of the leg. Proceeding from these attachments it descends and becomes tendinous; the tendon passes with that of the peroneus brevis, in a groove on the posterior

surface of the external malleolus, where it is covered by a fibrous lamella extended from the end of the fibula to the calcaneum, and invested by a common synovial membrane. The tendons then separate, that of the peroneus longus proceeds in another groove on the external surface of the calcaneum, to which it is connected by a separate fibrous sheath. It then enters a groove on the cuboïd bone, where it changes its direction, and inclines forwards and inwards beneath the foot, to be inserted into the tarsal end of the first metatarsal bone. *Structure*—tendinous at the lower, aponeurotic at the upper extremity, fleshy in the middle: *relations*—in the leg it corresponds by the outer surface with the fascia of the leg, by the inner surface with the fibula, extensor digitorum communis, and peroneus brevis; by the posterior surface, with the soleus superiorly, and flexor longus pollicis inferiorly. When passing across the foot, the tendon runs close to the bones, and therefore above all the plantar muscles.

243. The *peroneus brevis* (*moyen peronier*, Bichat; *grand peronien-sus-metatarsien*, Chauss., Dumas) is situated on the external side and lower part of the leg. *Form*—similar to that of the preceding muscle, but not so long. It *arises* from the external surface of the fibula, for about the lower half of its extent, and from the intermuscular septa which dip in between it and the contiguous muscles. The tendon passes behind the external malleolus, in the same groove and sheath, and is invested by the same synovial membrane with the preceding muscle, and is inserted into the base of the last metatarsal bone, after having traversed a separate groove in the calcaneum, situated above that for the tendon of the peroneus longus. *Structure*—tendinous at the lower extremity, fleshy superiorly: *relations*—by the outer surface with the peroneus longus and fascia of the leg; by the inner surface with the fibula, the extensor digitorum longus, the peroneus tertius, and flexor longus pollicis muscles.

Combined Actions.—The peronei are usually said to extend the foot, but their obvious action is to bend the foot upon the leg, so as to make them form a right angle. Extension of any particular part implies that it is brought as nearly as may be into a line with that on which it is moved; if so, the extensors of the foot must necessarily be placed at its posterior aspect, and are in fact the flexors of the toes, which when they continue their action, conspire with the tibialis posticus in extending the foot on the leg. The peroneus longus is enabled to evert the sole of the foot, by means of the mechanical advantage which it derives from turning round its external margin. This however is not readily perceptible in the natural condition of the limb; but if the fibula be fractured, and the check afforded by the external ankle, be in consequence diminished, it will take place to a considerable extent. When the peronei take their fixed point below, they act on the bones of the leg, and assist in maintaining them erect on the foot. This power is chiefly called into action when we stand on one leg. The weight of the body must then tend to incline the leg inwards; but the peroneus longus, acting from its fixed point in the sole of the foot, with the additional power given it by the pulley round which it turns, draws on the external side of the bones of the leg, and prevents them from obeying the influence which otherwise would incline them inwards.

Muscles on the posterior part of the Leg.

244. The *gastrocnemius, or gemellus (jumeaux,* Bichat; *bifemoro-calcanien,* Chauss., Dumas) is situated on the posterior surface of the leg, forming the greater part of what is named the calf. *Form*—very thick and convex behind, plane in front, divided longitudinally at the upper extremity into two portions or heads, of which the inner is thicker and longer than the other. From their relative situations they are named the outer and inner heads of the muscle. Each *arises* from the upper and back part of the corresponding condyle of the femur; their fleshy fibres descend converging, and both become gradually united so as to form a thick muscular mass. Below the middle of the leg, the mus-

cular structure ends in a broad strong tendon (*tendo Achillis*) which is inserted into the lower part of the posterior extremity of the os calcis. *Direction*—vertical: *structure*—tendinous at the lower extremity, aponeurotic and fleshy at the upper, fleshy in the middle: *relations*—the posterior surface is covered by the fascia of the leg, the anterior rests on the popliteus, plantaris and soleus muscles, and popliteal vessels; where its heads pass over the condyles, they are guarded by synovial membranes.

245. The *soleus* (*tibio-calcanien*, Chauss.; *tibio-peronei-calcanien*, Dumas) is situated at the posterior part of the leg, of which, in conjunction with the preceding muscle, it forms the calf. *Form*—nearly oval, being much thicker and broader in the middle than at the extremities. Like the preceding muscle it presents two heads, though by no means so distinctly separated. Of these the external one, longer and larger, *arises* from the posterior part of the head of the fibula, and from the surface beneath it for about a third of its extent, the inner head arises from the middle third of the tibia, commencing below the oblique line which gives insertion to the popliteus; finally, in the space intermediate between the bones, the muscular fibres are attached to a tendinous band extended from one to the other, over the posterior tibial vessels, which it secures from pressure or injury. The fleshy fibres descend lower than those of the gastrocnemius, and end in a flat tendon, which soon becomes blended with the tendo Achillis. *Direction*—the muscular fibres converge to a species of aponeurotic raphé, which exists along the middle of the muscle: *structure*—aponeurotic and fleshy at its origin, fleshy in the middle, tendinous inferiorly: *relations*—behind with the gastrocnemius and plantaris muscles; in *front*, with the peroneus longus, fibula, the flexor longus pollicis, tibialis posticus, and flexor longus digitorum muscles, the tibia, and the posterior tibial vessels.

246. The *tendo Achillis*, formed by the junction of the

tendinous structures in which the two preceding muscles terminate inferiorly, is situated at the posterior and inferior part of the leg. *Form*—elongated, narrower in the middle than at the extremities, of which the superior is broader than the inferior; where it passes over the posterior surface of the calcaneum, it is separated from the bone by a synovial membrane. It is covered behind by the skin and fascia of the leg; its anterior surface is separated by a considerable quantity of cellular tissue from the deep-seated muscles.

247. The *plantaris (petit femoro-calcanien,* Chauss., Dumas) is situated immediately behind the knee joint and leg, between the gastrocnemius and soleus; it consists of a very long thin tendon, and a small pyriform muscular part, about two inches in length. It *arises* from the femur just above the external condyle, and from the posterior ligament of the knee joint, where it is covered by the corresponding head of the gastrocnemius, and soon ends in a delicate tendon, which inclines inwards between the two large muscles of the calf of the leg, and running along the inner border of the tendo Achillis, is inserted conjointly with it into the posterior surface of the calcaneum. Its direction, structure, and relations, are here sufficiently indicated.

248. The *popliteus (femoro-popliti-tibial,* Chauss., Dumas) is situated immediately behind the knee joint, resting on its posterior ligament. *Form*—flat, triangular. It *arises* by a flat, thick tendon, about an inch in length, from a depression on the outer side of the external condyle, beneath the attachment of the corresponding lateral ligament of the knee joint, and is inserted into all that triangular surface of the tibia, which is above the posterior oblique line. *Direction*—obliquely downwards and inwards: *structure*—tendinous at its attachment to the femur, aponeurotic and fleshy in the rest of its extent: *relations*—behind with an expansion continued over it from the semi-membranosus, with the popliteal vessels, the plantaris and gastrocnemius muscles;

in front, with the knee joint and tibialis posticus muscle. The tendon by which it is connected to the femur, adheres to the external semi-lunar cartilage, (which sometimes is grooved for it) and is invested by the synovial membrane of the knee joint.

Combined Actions.—The power of these muscles, as they are exerted successively in standing, walking, running, &c. is very considerable. In standing, the gastrocnemius and soleus take their fixed point at the os calcis, and by drawing on the bones of the leg, retain them perpendicularly on the foot, thus preventing them from obeying the influence of the weight of the body, which constantly tends to bend them forwards. If this effort be carried as far as it will admit of, the gastrocnemius and popliteus will bend the femur on the tibia, and if at the same time the semi-tendinosus, semi-membranosus, and biceps, be made to act on the ischium, so as to draw it downwards and backwards, the commencement of that series of muscular actions is made, by which the body is retroverted, and carried towards the ground, as we see when a tumbler or mountebank makes an inverted arch of his body, the head and heels being brought to the same plane. In walking these muscles take their fixed point above, and by drawing on the os calcis lift it from the ground, so that the foot is made to represent an inclined plane. By this action an impulse is communicated to the body, and a direct tendency is given to progression. When the body is thus supported on the elevated foot, the opposite limb can be carried forward to its destination unimpeded by the inequalities of the surface over which it has to pass. It may be observed, that an individual who is obliged to use a wooden leg, usually selects it a little longer than the limb for which it is substituted. This choice is determined not merely with a view to lessen the jar or concussion, caused by resting the body on an unyielding, inelastic support; it is the result of experience, which teaches that the natural limb cannot be carried with facility before the artificial one unless the latter is a little longer, and so serves as a substitute for that power of elevating the heel, which under such circumstances is wanting.

249. The *flexor longus digitorum pedis* (*flexor perforans*:

tibio-phalangettien commun, Chauss.; Dumas) is situated at the posterior part of the leg close to the bones, and beneath those of the foot. *Form*—elongated, flat and thin superiorly, divided into four tendinous portions towards its insertion. It *arises* from the posterior surface of the tibia, below the oblique line which gives attachment to the popliteus and soleus, and continues its attachment to within three inches of the inner ankle, some fibres also arise from an aponeurosis, which connects it with the tibialis posticus, and flexor longus pollicis. The fleshy fibres pass obliquely into a tendon situated at the posterior aspect of the muscle. The tendon passes behind the internal malleolus along a groove common to it and the tibialis posticus (the latter being next to the bone); from thence it is directed through a groove in the calcaneum, obliquely forwards and outwards into the sole of the foot, where it is crossed by the tendon of the flexor longus pollicis, with which it is connected by a transverse tendinous slip. The tendon then divides into four processes, corresponding with the four lesser toes, and as they run along their under surface, they are bound down to the phalanges by fibrous sheaths; opposite the second phalanx, each tendon passes through a fissure in the tendon of the flexor brevis (whence the terms, perforans is applied to the one, perforatus to the other), and, finally, they are inserted into the bones of the third phalanges. Previously to its division, the tendon of the flexor longus gives insertion to an accessory muscular structure (flexor accessorius), which connects it with the calcaneum, and materially modifies the direction of its action on the toes. Close to the point of division the tendons give origin to four small muscles (lumbricales) which pass forwards to be inserted into the first phalanges of the four lesser toes; these may also be considered as accessories to the flexor longus. Though in the dried bone only one impression is marked for the tendons of the tibialis posticus and flexor longus, the fibrous sheath which retains them in their situation is divided into two parts by a septum, or partition, so that each runs in a separate groove lined by a distinct synovial membrane. *Direction*—vertical in the leg, horizontal in the foot: *structure*—fleshy and tendinous: *relations*—in the leg it is bound down by the deep fascia, and covered by the posterior tibial vessels, which separate it from the soleus; its anterior surface rests against the tibia, and overlaps the tibialis posticus muscle; in the foot its tendon lies between those of the flexor longus pollicis, and peroneus longus, (which are above it, and nearer to the tarsal bones) and the flexor brevis digitorum which lies beneath it.

250. The *flexor longus pollicis pedis (peroneo-sous-phalangettien du pouce*, Chauss.) is situated close to the fibula, along the external side of the leg, and at the under and inner part of the foot. It *arises* from the posterior surface of the fibula, (its inferior two thirds) slightly from the interosseous ligament, and from the intermuscular septa interposed between it and the peronei externally, and the flexor longus digitorum and tibialis posticus internally. The fleshy fibres, continuing to arise nearly as far as the external ankle, pass obliquely into a tendon placed on their posterior surface; the tendon traverses a groove on the tibia, external to that which transmits the tibialis posticus and flexor digitorum, then passes through another in the astragalus, and so reaches the sole of the foot, where, after being connected to the common flexor by a tendinous slip, it turns forwards beneath the metatarsal bone of the great toe, and between the two heads of the flexor brevis pollicis, and, after running through a fibrous sheath which binds it to the first phalanx of the great toe, is inserted into the base of the second. *Structure*—fleshy in the greater part of its extent, tendinous inferiorly: *relations*—in the leg it is bound down by the deep fascia which separates it from the soleus; its anterior surface rests on the fibula, and overlaps

the tibialis posticus, and peroneal artery; its relations in the sole of the foot have already been sufficiently indicated.

251. The *tibialis posticus* (*tibio-sous-tarsien*, Chauss.) lies deeply behind the bones of the leg and interosseous ligament. Its superior extremity is divided into two short processes, or heads, by an angular interval for the transmission of the anterior tibial artery. It *arises* from the posterior flat surface of the tibia, beginning below the oblique line of insertion of the popliteus, its fibres continuing to be attached to the bone for some way down, also from the posterior surface of the fibula, and from the interosseous ligament for two thirds of its length; some fibres arise also from the intermuscular septa, between it and the flexor muscles. The muscular fibres end in a flat strong tendon, which winds round the internal malleolus close to the bone, and in a sheath appropriated to itself, from whence it is directed forwards, beneath the tarsus, to be inserted into the tuberosity on the plantar surface of the scaphoïd bone, several fibres being also prolonged to the first cuneïform, and some obliquely into the sole of the foot, as far as the second and third metatarsal bones. *Direction*—vertical in the leg, horizontal in the foot: *structure*—fleshy and tendinous: *relations*—in the leg it is overlapped and concealed, in the greater part of its extent, by the two flexor muscles, but superiorly, the part left uncovered by them supports the posterior tibial vessels; its anterior surface rests against the interosseous ligament, and the tibia and fibula, from which it arises; its tendon runs close to the inner ankle and tarsal bones, and where it slides under the astragalus is thickened by a cartilaginous, or bony deposit within its fibres, analogous, in form and use, to the sesamoïd bones in other situations.

Combined Actions.—Like their antagonists on the fore part of the leg, these muscles act, in the first instance, on the phalanges, and in the next place on the foot. The latter effect they are enabled to produce by means of the mechanical advantage afforded them by the pulley-like surface on which they slide, as they pass from the leg into the sole of the foot. By this provision the flexor muscles conspire with the soleus and gemellus in extending the foot on the leg, and thus making the body to rest on the toes. The direct agent in extending the foot upon the leg is the tibialis posticus; but from its position it is also enabled to turn the foot inwards, thus antagonizing the peroneus tertius which tends to turn it outwards. It may also, by elevating the inner border of the foot, turn the sole inwards; which action is directly opposed to that of the peroneus longus, which tends to incline it outwards. When these muscles take their fixed point of attachment below, they exert a considerable degree of power in keeping the bones of the leg perpendicularly on the foot, and so assist in maintaining the erect position of the body. It may be observed that the toes would, in all cases, be drawn inwards whilst they are being flexed by the flexor communis, in consequence of the oblique direction of its tendon, but for the influence exerted upon it by the accessory muscle, which is connected with it in the sole of the foot. The direction of the latter being from behind forwards, it is well fitted by its contraction to modify the action of the long flexor on the toes, and to draw them towards the heel, where its fixed point of attachment is situated.

Muscles of the Foot.

252. The only muscle on the dorsum of the foot is the extensor brevis digitorum, which has been already described, together with the extensor longus, as they conspire in their actions; the present section therefore includes only the muscles in the sole of the foot. These may be considered as divisible into three regions, corresponding with the two borders and the intermediate space; the internal set, consisting of the muscles of the great toe, the external, those of the little toe, those in the middle being common to all. But in order to facilitate the examination of the parts contained in the sole of the foot, it is found far more convenient to divide them into layers, lying one beneath the other, more particularly, as like the muscles on the back

part of the leg, they are found to be separated into a superficial and deep set, by a layer of fascia interposed between them, and binding down the latter.

253. The *abductor pollicis* (*calcaneo-sous-phalangien du pouce*, Chauss.) is placed along the inner side of the sole of the foot. It *arises* from the inner border of the protuberance of the calcaneum, from the internal annular ligament, and from the septum between it and the flexor brevis digitorum. The fleshy fibres end in a tendon, which, after uniting with the external head of the flexor brevis pollicis, is inserted into the inner border of the base of the first phalanx of the great toe. *Direction*—parallel with the inner border of the foot: *structure*—fleshy and tendinous: *relations*—its plantar surface is covered by the skin and fascia, the superior surface is in contact with the tendinous insertion of the tibialis posticus, with the flexor brevis pollicis with which it is identified, and with the internal plantar vessels.

254. The *flexor brevis digitorum* (*flexor perforatus; calcaneo-sous-phalanginien commun*, Chauss.) is placed in the middle of the sole of the foot, in intimate contact with the plantar fascia. It *arises* from the plantar surface of the calcaneum, immediately before its internal or greater tuberosity, from the plantar fascia, and the intermuscular septa on each side. It soon terminates in four thin tendons corresponding with the four lesser toes; and opposite the extremity of the first phalanx, each tendon divides into two fasciculi, so as to leave a fissure for the transmission of the tendon of the flexor longus, after which the fibres unite again into a broad lamella, which is inserted into the under surface of the second phalanx. *Direction*—directly forwards: *structure*—tendinous and fleshy behind, fleshy in the middle, tendinous in front: *relations*—the lower surface is in contact with the plantar fascia, the upper with the flexor accessorius, with the tendons of the flexor longus digitorum, the lumbricales, and the plantar vessels.

255. The *abductor digiti minimi* (*calcaneo-sous-phalangien dupetit orteil*, Chauss.) is placed along the external border of the foot. It *arises* from the external border and under surface of the calcaneum, immediately before its external or smaller tubercle, and from the upper surface of the process of the plantar fascia which extends from that tubercle to the base of the fifth metatarsal bone. The fleshy fibres end in a tendon, which after sliding along a smooth impression on the inferior surface of the head of the fifth metatarsal bone, is inserted into the external surface of the base of the first phalanx of the little toe. Its direction and structure are here sufficiently indicated. *Relations*—the inferior surface is covered by the plantar fascia, the superior is in contact with the external head of the flexor accessorius, the ligamentum longum plantæ, and the flexor brevis digiti minimi.

When these muscles are removed, a thin lamella of membrane will be observed, extending across from one side of the foot to the other, and binding down the second layer of muscles, consisting of the tendons of the flexor longus pollicis, those of the flexor communis, and its accessories, viz. the flexor accessorius and lumbricales. The long tendons will be observed to cross one another at an acute angle, that of the flexor pollicis inclining inwards, and placed on a plane superior to the tendon of the flexor communis, whose direction is obliquely outwards, as if towards the base of the fifth metatarsal bone.

256. The *flexor accessorius* is not unfrequently termed *massa carnea;* but its structure does not at all warrant such an appellation, as one of its origins is tendinous, and at its point of union with the flexor longus, it is for the most part tendinous. It is divided posteriorly into two heads, of which the internal or larger one *arises* from the sinuosity of the calcaneum, the external, flat and tendinous, arises from the plantar surface of that bone, a little before its external tubercle. These origins unite at an acute angle, and form a

flat fleshy mass, which becomes united to the posterior border, as well as the two surfaces of the tendon of the flexor longus at its point of division. It may be observed, that the fibres of the accessory muscle, where they enclose the tendon of the long flexor, are tendinous, and so arranged as to form a groove, within which it is lodged.

The *lumbricales* (*les quatre planti-sous-phalangiens*, Chauss.) are four small tapering muscles which *arise* from the tendons of the flexor communis digitorum at their point of division; from whence they pass forwards to the inner side of each of the lesser toes, and become united to the tendinous expansions of the extensor muscles on the dorsal surface of the phalanges.

When these muscles are removed, the third layer is exposed filling up the deep irregular part of the sole of the foot.

257. The *flexor brevis pollicis* (*tarso-sous-phalangien du pouce*, Chauss.) single and pointed behind, divided into two parts or heads in front, it *arises* by a flat tendinous process, which extends along the greater part of its upper surface, from the inner border of the cuboïd bone, slightly from the contiguous margin of the external cuneïform bone, and from the tendinous fibres sent into the sole of the foot from the tendon of the tibialis posticus. These origins can be best perceived when the muscle is cut across, and detached carefully from before backwards. The fleshy mass divides into two heads, which are inserted, one into the inner, the other into the external border of the base of the first phalanx of the great toe. But before reaching the point of insertion, an intimate union is established between it and the abductor pollicis on the one side, and adductor on the other. The tendon of the flexor longus runs along the interval between the heads of this muscle.

258. The *adductor pollicis pedis*, is situated obliquely in the sole of the foot, forming a thick fleshy mass. It *arises* from the middle and external cuneïform bones, from the

tarsal extremity of the third and fourth metatarsal bones, also from the sheath of the peroneus longus muscle, and is inserted conjointly with the external head of the flexor brevis pollicis, into the base of the first phalanx of the great toe.

The adductors of the great toe, and its short flexor, are thus found to be intimately united at their insertion, and if they be cut across about an inch behind the first joint, and reflected forwards, two small sesamoïd bones will be found embedded in their structure, just as the patella is in the extensor tendons of the knee joint. Like the latter bone, one of their surfaces is smooth, and enters into the composition of the articulation, being lined by the synovial membrane, and like it they are developed in the substance of the tendons, to increase their power of action.

259. The *transversus pedis* (*metatarso-sous-phalangien du pouce*, Dumas) is a narrow flat fasciculus of fleshy fibres, stretched beneath the digital extremities of the metatarsal bones, being interposed between them and the flexor tendons. Its external extremity is attached usually to the lateral ligament connecting the fifth metatarsal bone with the first phalanx of the little toe, sometimes it commences at the fourth; it passes from without, inwards, towards the ball of the great toe, where it becomes blended with the fibres of the adductor pollicis.

260. The *flexor brevis digiti minimi* (*metatarso-phalangien du petit orteil*, Dumas) placed at the external side of the sole of the foot, it arises tendinous from the base of the fifth metatarsal bone, and from the sheath of the peroneus longus; the fleshy fibres terminate in a tendon, which is inserted into the base and external border of the first phalanx of the little toe. *Direction*—horizontally forwards: *structure*—fleshy in the middle, tendinous at the extremities: *relations*—its superior surface is in contact with the fifth metatarsal bone; the inferior is covered partly by the abductor digiti minimi, partly by the plantar fascia.

261. The *interossei,* as their name implies, are placed between the metatarsal bones, filling up the intervening spaces. There are seven in all. On the dorsal aspect of the metatarsus, four of these muscles are perceptible, but still they dip down into the sole of the foot, where the other three are altogether situated; hence it is, that in the latter situation, their appearance and arrangement are somewhat complex.

262. The *dorsal,* or *superior interossei* (*sus-metatarso-lateri-phalangiens,* Dumas) closely resemble one another in appearance and mode of attachment. Their fibres arise from the contiguous surfaces of the bones between which they are placed, and pass obliquely forwards to a slight tendon that runs along the centre of each, so that they form a double penniform muscle, the posterior extremity of which is bifid, leaving an angular interval for the passage of the perforating branches, which pass from the plantar to the dorsal arteries. The two first dorsal interossei belong to the second toe, being inserted, the one into the internal, the other into the external side of its first phalanx. The third is inserted into the external side of the first phalanx of the third toe, and the fourth terminates in like manner in the first phalanx of the corresponding toe.

263. The *plantar* or *inferior interossei* (*sous-metatarso-lateri-phalangiens,* Dumas) are not, strictly speaking, situated between the metatarsal bones, they are placed rather beneath the third, fourth, and fifth metatarsal bones, inclining somewhat towards their inner border.

264. 1. The *first* plantar interosseous muscle arises from the internal border of the third metatarsal bone. The fleshy fibres end in a tendon, which is inserted into the base of the first phalanx of the third toe, becoming blended with the tendinous expansion of the extensor communis.

2. The *second* plantar interosseous muscle arises from the inner side of the fourth metatarsal bone, and is inserted

into the inner border of the first phalanx of the corresponding toe, and the extensor tendon.

3. The *third* dorsal interosseous arises from the inner side of the fifth metatarsal bone, and is inserted into the base of the first phalanx of the little toe, and the extensor tendon.

Combined Actions.—Several anatomists name the different interosseous muscles, not from their numerical order, first, second, third, &c. but from their actions and uses. Thus, the second, third, and fourth, of the dorsal set, are abductors of the corresponding toes, inasmuch as they are inserted into the external side of their phalanges; but the first dorsal and the three plantar muscles are adductors, so that if all four act together, they will draw the four lesser toes to the great one. Though the power of adduction and abduction is found in the digital phalanges of the foot, it is obviously very much restricted, as compared with the hand; and when we examine the rest of the muscular apparatus in this region, we shall see sufficient reason to admit, that, though it is constructed on the same general principle as that of the hand, and made up of nearly similar parts, its powers are modified and adapted to the peculiar uses of the foot, which forms a basis of support for the body, as well as an instrument of propulsion in its different movements. It may be observed, that from the analogy between the general construction of the great and little toes, and the thumb and little finger, the muscles of the former have received the same names as those of the latter, as if they could perform the same uses and exert the same actions. Thus the little toe has its abductor, flexor, and adductor (the third plantar interosseous) though it admits of scarcely any motion by itself. The size of the muscles also shews that they are intended for some more important purpose than the movement of so small a part. The nomenclature of the muscles of the great toe has also been constructed on the supposition of its admitting of abduction and adduction like the thumb. But the mode in which its metatarsal bone is articulated with the first cuneïform bone, as well as the circumstance of its digital extremity being connected with the other toes, by the transverse ligament and transverse muscle, shews that these movements are, as it were, rudimentary, and have little to do with the proper function of the part. Further, the three plantar muscles of the great toe are united so intimately together at their insertion, and for some way before it, that it is scarcely possible for them to act singly, or independently of one another; if so, they conspire in some common action, which is simply, that of flexion. The bulk and power of these muscles are obviously disproportioned to the size of the part (the first phalanx) which they act on, as well as to the extent of any motions of which it admits. The same remark extends to the short muscles of the little toe, and generally to the flexors of all the toes, if a comparison be instituted between the moving powers and the things to be moved, supposing the phalanges to rank as the latter. Now when we examine with attention the muscular apparatus of the foot, after having studied the structure and mode of adaptation of its different osseous pieces, we see abundant evidence of its being fitted to sustain strong and powerful efforts as a whole, rather than to admit of such free and varied motions amongst its parts as take place in the hand. Thus the oblique direction of the adductor and short flexor of the great toe, as well as of the little toe, enables them to draw the bones of the foot together, at the same time that they curve them downwards, and increase the arched form of the foot. Even the abductors of the great and little toes may, in some degree, conspire to the same end; for as their posterior attachment is nearer the median line than the anterior, they will draw the borders of the foot inwards. These are not the only provisions for concentrating the metatarsal bones. The tendon of the peroneus longus passing across them from without inwards, and that of the tibialis posticus in the opposite direction (at least that part of it which is prolonged to the third and fourth metatarsal bones) contribute to the same effect, as does also, but in a very minor degree, the crossing of the tendons of the flexor longus pollicis, and flexor communis. All these facts tend to prove, that the aggregation and fixity of the different parts of the foot have been abundantly provided for, in order to render it a secure basis of support to the body, and that the muscular apparatus by which it is flexed and incurvated downwards, denote it to be what we have here ventured to designate it,—a powerful instrument of propulsion in the different movements and actions of the lower extremity.

SECTION II.

ARTERIES OF THE ABDOMINAL PARIETES, AND LOWER EXTREMITY.

WE commence the description of the vessels which supply the walls of the abdomen, and the lower extremities, at the point at which the aorta divides into the common iliac trunks. The bifurcation of the aorta takes place usually on the body of the fourth lumbar vertebra, a little to the left of the middle line. The point here indicated, will be found on a level with a line drawn from one crista ilei to the other, and may be transfixed by another passed horizontally backwards from the left margin of the umbilicus, to the vertebral column, in the erect position of the body. It should, however, be observed, that the division not unfrequently takes place higher up or lower down, by about the breadth of half a vertebra.

265. The *common iliac trunks* (*arteriæ iliacæ communes*) resulting from the bifurcation of the aorta, diverge as they pass downwards and outwards to the sacro-iliac symphysis, where each of them divides into two primary branches, the internal and external iliac arteries, the former being distributed to the viscera of the pelvis, and the soft parts on its external surface, as well as to the perinæum, whilst the latter is prolonged into the lower extremity, after having sent two important branches to the parietes of the abdomen. The common iliac arteries of opposite sides present some differences in their direction, length, and relations to contiguous parts, which deserve notice. The vessel on the right side passes off more abruptly than the left, and is somewhat longer, as the division of the aorta occurs to the left of the middle line. The right one also lies obliquely on the last lumbar vertebra, from which it is separated by both the common iliac veins, as they terminate in the cava.

Both these vessels are covered by the peritonæum, and crossed by the ureters just at their point of division; the right being also crossed by the ileum, where it is about to pass into the large intestine; whilst the left lies behind the sigmoïd flexure of the colon. To the inner side of the left iliac artery, and supported on the lumbar vertebra, lies its accompanying vein; on the right side the vein lies nearly behind the artery. No branch that has received a name or deserves notice, is given off by the common iliac arteries; but on reaching the sacro-iliac symphysis, as has been observed, each divides into the internal and external iliac arteries. The latter we shall describe first, as in the adult subject it approaches more nearly both in size and direction the vessel from which it arises. It may be here observed, that the vessel whose branches supply the lower extremity continues an undivided trunk from the point already indicated (*sacro-iliac symphysis*) as far as the lower border of the popliteus muscle, where it divides into the anterior and posterior tibial arteries; but though it continues thus undivided, different parts of it have received different names, taken from the anatomical regions through which it passes. Whilst within the pelvis, and running along the iliac region, it is named *iliac;* in the upper two-thirds of the thigh, *femoral;* from thence, to the lower boundary of the ham, *popliteal.* Each of these divisions, (which are really artificial, being intended merely to facilitate description) is marked by some change in direction, in relation to contiguous parts, and also by a diminution in size, proportioned to the decrease in the quantity of contained fluid consequent on the giving of branches of supply at different intervals.

266. The *external iliac artery,* (*iliaca externa,* Murray; *arteria cruralis in pelvi,* Soemm.) extends from the sacro-iliac symphysis to Poupart's ligament, its direction being obliquely downwards and outwards, so as to reach the middle point between the anterior superior spinous process of

the ileum, and the symphysis pubis. In this course the vessel presents a slight curve, whose concavity looks backwards into the pelvis; but it gives no branch of any consequence, until it arrives within a few lines of its termination. It at first rests somewhat on the external iliac vein, as it descends it receives some support from the psoas muscle being closely applied to its inner margin, and finally rests upon it for some way. To its external side lies the psoas muscle in its whole course, which separates it from the anterior crural nerve; the internal inguino-cutaneous branch of the nerve, crosses in front of the artery, as it passes inwards to its destination. Anteriorly, the external iliac artery is covered by the peritonæum; internally, it is accompanied by the vein of the same name, which at first is placed rather behind it, but gradually comes forward, so as to lie on the same plane when they have reached Poupart's ligament. The artery at this point is supported by some fibres of the psoas muscle, the vein by the pubis, where a small part of its upper surface remains uncovered by muscular fibre, between the contiguous borders of the psoas and pectineus. Just before its termination the artery gives its two branches, viz. the epigastric and circumflexa ilei.

267. 1. The *epigastric artery* is situated obliquely at the inferior and anterior part of the abdominal parietes. It arises from the external iliac, usually about three or four lines above the margin of Poupart's ligament; in some instances, it comes off on a level with it, or even lower down. In the first case it inclines downwards and inwards, so as to get on a level with the ligament, after which it changes its direction, passing obliquely upwards and inwards, being placed between the fascia transversalis and the peritonæum, until it reaches midway between the umbilicus and pubis, where it passes into the sheath of the rectus, in which it ascends above the umbilicus, and terminates in several small branches that anastamose with the terminal branches of the internal mammary, and inferior intercostal arteries.

The epigastric artery is accompanied by one or two veins; it is crossed by the vas deferens, which at first lies in front of it, then turns round its external side, as it descends towards the pelvis. The vessel is therefore placed at the inner side of the internal abdominal ring, through which the spermatic cord passes. Its branches are as follows:

a, A small branch passes along the spermatic cord beneath the cremaster muscle, escapes through the external abdominal ring, and after supplying the parts in the cord, anastomoses with the proper spermatic artery: *b*, several muscular branches pass from its inner and outer sides to the parts along which it runs: *c*, some come forwards through the muscles, become sub-cutaneous, and communicate with the superficial epigastric artery: *d*, the terminal branches ascend in the substance of the rectus muscle, and anastomose with the internal mammary.

268. 2. The *circumflexa ilei* artery, smaller than the preceding, is placed obliquely along the lower border of the abdomen. It arises from the external side of the iliac artery, on a level with Poupart's ligament, whose direction it takes as it runs upwards and outwards to the anterior superior spine of the ileum, where it turns along its crista, and divides into several branches, which are distributed to the abdominal muscles. About an inch after its origin, this artery pierces the fascia iliaca, and runs for some way between it and Poupart's ligament (corresponding with the line of insertion of that membrane), but opposite the superior spinous process of the ileum, it gets between the transversalis and internal oblique muscle, to which it is finally distributed. It sends off,

a, Some slight twigs, which pierce the muscles, and along the groin anastomose with the superficial circumflexa ilei, which comes from the femoral artery: *b*, several smaller branches, which pass inwards on the iliacus muscle, and anastomose with the ileo-lumbar artery; *c*, its terminal branches, which in the substance of the abdominal muscles communicate with the lumbar arteries on the one hand, and the epigastric on the other.

Dissection and operations.—As the iliac artery and its branches are usually studied immediately after the abdominal viscera have been examined, very little dissection is required to expose them in their entire extent. If the lower part of the parietes of the abdomen be turned down on the thigh, after the viscera have been removed, nothing more is necessary than to gently elevate the peritonæum from the iliac fossa, and draw it inwards towards the pelvis. The trunk of the vessel will then be observed resting on a smooth dense membrane *(fascia iliaca)* which is placed behind it, separating it from the psoas muscle; it is however bound down to the fascia by the sub-serous cellular tissue, which adheres firmly to it on each side of the vessel. The epigastric artery, if injected, may also be exposed in the lower and more important part of its course in the same way, namely, by removing the peritonæum from the fascia transversalis, which at once shews its relation to the cord and internal ring; to trace it higher up, the sheath of the rectus must be opened. If the abdomen be not opened, it will be necessary to cut through the three layers of abdominal muscles, in order to reach the epigastric artery. The direction of the vessel may be indicated by drawing a line from a little to the pubic side of the middle point, between the superior spine of the ileum, and the symphysis pubis upwards, to the side of the ensiform cartilage.

In order to expose the external iliac artery in the living subject, it becomes necessary to divide the muscular parietes of the abdomen without injuring the peritonæum, after which this membrane must be pushed upwards from the iliac fossa. For this purpose, in conformity with general usage, (which prescribes, that when cutting down on an artery, the incision should coincide with the direction of the vessel) Mr. Abernethy makes an incision about four inches long over the course of the artery. As the aorta divides on the fourth lumbar vertebra, and as the external iliac artery terminates midway between the anterior spine of the ileum and the pubic symphysis, it would at first sight appear, that a line drawn from the umbilicus to the latter point, would sufficiently indicate the course of the vessel, which in this, as in all other operations, it is a matter of great consequence to determine accurately. But this line would fall to the inner side of the vessel, more particularly at the right side, in consequence of the transverse direction of the common iliac artery. Hence the sacro-iliac symphysis, being the commencement of the external iliac artery, is the point over which the line must pass, in order that it may coincide with the direction of the vessel. If then from midway between the anterior superior spine of the ileum and the symphysis pubis, a line be drawn upwards to about an inch to the outside of the umbilicus, it will mark the course of the external iliac artery. The incision through the integuments (the patient being placed in the horizontal position) should begin four inches and a half above Poupart's ligament, and end within half an inch of that line. This exposes the aponeurosis of the obliquus externus, which is to be divided in the same direction and extent. The fore-finger of the left hand should in the next place be insinuated beneath the lower border of the obliquus internus and transversalis muscles, in order to detach them from the peritonæum; but some difficulty will be experienced in effecting this, as it is necessary to tear through the fascia transversalis, which is rather firm in this situation. When the muscles have been elevated for some way, they are to be cautiously divided by a probe-pointed bistoury, carried along the finger. It then only remains, in order to obtain a view of the artery, to push the bag of the peritonæum from below upwards and inwards, towards the margin of the pelvis. It should however be recollected, that as the artery is in some measure bound down to the fascia iliaca, by the sub-serous cellular tissue which adheres rather firmly to that membrane, it becomes necessary to free it from this connexion, by carefully scraping, with the extremity of a probe, or with the nail, before the needle can be passed round it. As the vein lies close to the artery on its inner side, the needle must be insinuated between them, and passed from within outwards. No nerve is implicated in this operation, the anterior crural being separated from the artery by the breadth of the psoas muscle.

The mode of incision here pointed out by cutting across the fibres of the abdominal muscles, necessarily weakens them, where they most require to be strong. Its chief recommendation is, that it enables the operator to place the ligature higher up on the vessel than he could do otherwise, on which account it may be the only operation admissible in certain cases, for instance, where an aneurismal tumour has extended as far as Poupart's ligament, or a little above it. It may be farther observed, that whilst the operation is being performed in this way, much difficulty is experienced in keeping the vessel exposed, after the peritonæum and intestines have been pushed up, as they are continually forced down by the descent of the diaphragm; and as the sides of the wound are held apart by two retractors, it is difficult, if not impossible, to apply a third at its superior angle, so as to bear off the peritonæum and viscera.

Sir Astley Cooper adopts quite a different method of operation; his incision is somewhat transverse, with regard to the course of the artery. Commencing about half an inch above, and to the pubic side of the spine of the ileum, he divides the skin in a direction parallel with that of Poupart's ligament, the incision being prolonged somewhat further than midway between the spine of the ileum and symphysis pubis. The point specified is the inner margin of the abdominal ring; but this is not a good point of reference, as it is not perceptible or tangible before the incision is made. The fibres of the external oblique are in the next place to be divided to the same extent; and when the lunated flap thus formed is elevated, the lower border of the obliquus internus and transversalis is exposed, as well as the spermatic cord, as it passes beneath them. The cord will then serve as a guide to the epigastric artery, in front of which it lies; and this vessel in turn to the iliac artery, which can be detached from its connexions without any further dissection. With this view the finger is passed along the cord, and through the fascia transversalis, or rather through the opening in it, which transmits the cord, the artery is then felt pulsating, and may be secured in the way recommended in the other mode of operation.

269. The *femoral artery (femoralis communis,* Murray) is placed along the anterior and inner side of the thigh, extending from Poupart's ligament, where it is continuous with the external iliac, as far as the junction of the middle with the inferior third of the thigh, at which point it changes its name and relation to the bone, becoming *popliteal.* If the knee be semi-flexed, and the limb rotated outwards so as to turn the flat or inner side of the thigh somewhat forwards, the course of the vessel may be marked out by a

line drawn, or a cord extended from midway between the anterior superior spine of the ileum, and the symphysis pubis, to the lower border of the patella. In this position of the limb, the vessel cannot be said to incline inwards; but if the subject be laid on the back, and both legs be placed closely together, the arteries of opposite sides will be nearer to one another, and therefore to the median line, in the popliteal space, than when under Poupart's ligament, which indicates a slight inclination inwards. A cursory inspection would however lead us to suppose the inclination to be greater than it really is, which is owing to the oblique direction of the femur. This is by no means a matter of indifference in a practical point of view. The saphena vein has been wounded in a few instances during the operation for tying the femoral artery. This accident may happen to any individual, who, from supposing that the artery inclines inwards as it descends, makes his first incision oblique, so as to correspond with such a direction of the vessel. It has been said,* that if a line be drawn from midway between the spine of the ileum and the symphysis pubis, down to the middle of the popliteal space, it will indicate the course of the vessel. This is nearly correct; but as it runs along the inner surface of the thigh, its course is rendered much more oblique than that of the vessel which is placed so much nearer the shaft of the femur. In the skeleton, whilst the femur hangs freely, a plummet line suspended from midway between the pubic symphysis and spine of the ileum, will drop exactly between the condyles of the femur, and mark as nearly as can be for all practical purposes, the direction of the artery. In the upper third of the thigh it is perpendicularly downwards, some slight deviation inwards may exist in the middle third, where the vessel is borne off from the bone by the vastus muscle; but this cannot be so great as to require any obliquity in the direction of an incision, made with the view of exposing it.

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* Boyer, *traité d'Anatomie*, tom. iii.

270. The direction of the vessel may then be said to be downwards along the anterior and inner side of the thigh, becoming gradually deeper as it descends, and in its course it lies first on the psoas muscle, (supported on its inner border), which separates it successively from the os pubis, the brim of the acetabulum, and the hip joint. Below this, the vessel rests on some branches of the profunda artery and vein, embedded in cellular tissue; these separate it from the pectineus and adductor brevis; it then passes over the adductor longus, and finally over the conjoined tendons of the latter and adductor magnus. Internally, it is in contact with the femoral vein, both vessels lying on the same plane in the first instance, where they are supported by the pubis; but when the vein sinks behind the artery, the latter comes into contact with the adductor longus and sartorius muscles. Externally it rests against the psoas muscle, which separates it from the crural nerve; but after that muscle has sunk backwards to its insertion, three or four branches of the nerve come into contact with the sheath of the vessels.

271. The anterior surface of the artery in the superior third of the thigh, is covered only by the common integument, the superficial fascia, the inguinal glands, and the fascia lata, so that it is comparatively superficial, and may be easily compressed against the acetabulum and head of the femur. In the middle third of the limb, the vessel is more deeply seated, as in addition to the parts already mentioned, it is covered by the sartorius muscle, beneath which may be observed a fascia, composed of oblique fibres passing from the adductor muscles to the vastus internus. This is thin superiorly, beginning where the sartorius overlaps the vessels, but gradually becomes dense and firm, as it approaches the point at which the vessel passes through the opening in the adductor magnus, (sect. 223). Though at Poupart's ligament, the femoral vein lies close at the inner side of the artery, and on the same plane with it; it

is not however supported by any muscular fibres; it rests on that part of the brim of the pelvis which corresponds with the interval between the contiguous borders of the psoas and pectineus muscles, separated from the bone merely by the prolonged part of the fascia iliaca, which passes down behind the vessels. As the vein descends it gradually sinks backwards, coiling round the artery, so that on reaching the popliteal space, it is situated to the outer side and behind that vessel. The crural nerve, at its exit from the abdomen, lies about three quarters of an inch to the outside of the artery, being separated from it by the breadth of the psoas muscle; but when the muscle sinks backwards towards the trochanter minor, two or three branches of the nerve incline towards the artery, and accompany its sheath for some way; of these the largest, which from its ultimate distribution is called nervus saphenus, pierces the sheath and lies on the superior and external side of the artery, during the middle part of its course, whilst the vein is situated posteriorly and internally for the same extent. This nerve does not accompany the artery and vein as they pass backwards through the adductor magnus; it continues directly downwards to the inner condyle of the femur, and may be found between the tendons of the gracilis and sartorius muscles.

Branches of the Femoral Artery.

272. The femoral artery gives off its chief branches in the superior part of its course, whilst it is yet uncovered by muscle. Some of these, small and unimportant, are distributed to the inguinal glands and adjacent muscles; others, though small, have received names, and require a separate notice, viz. the external pudic (superior and inferior), the superficial epigastric, the superficial circumflexa ilei, and finally a branch of considerable size, the profunda femoris.

1. The *external pudic arteries* (*arteriæ pudendæ externæ*) arise either separately, or by a common origin, from the internal side

of the femoral. The *superior*, or more superficial one, passes upwards and inwards to the spine of the pubis, crosses the situation of the external abdominal ring, and is distributed to the integuments at the lower part of the abdomen, and the external parts of generation. The *inferior* and deeper seated one, passes inwards, resting on the pectineus, and covered by the fascia lata, which it pierces on reaching the ramus of the pubis, and is distributed to the scrotum in the male, or labium in the female, its branches inosculating with those of the superficial perineal artery. The superior branch is necessarily cut across, whilst the integuments are being divided in the operation for inguinal hernia.

2. The *superficial epigastric artery* (*epigastrica superficialis*) arises from the femoral, about half an inch below Poupart's ligament, passes forwards through the saphenic opening in the fascia lata; after which it changes its direction, and runs perpendicularly upwards between the obliquus externus and the integuments. Its terminal branches ascending as high as the umbilicus anastomose with those of the proper epigastric and internal mammary arteries. The rest of its branches ramify in the cellular tissue and superficial fascia, on the lower part of the abdomen. This vessel must be divided by the transverse incision made through integuments in the operation for femoral hernia.

3. The *superficial circumflexa ilei* artery runs outwards and a little upwards to the spine of the ileum, parallel with Poupart's ligament, crossing the psoas and iliacus muscles, to which it gives some branches. It terminates in several small twigs, which pierce the fascia lata, and anastomose with similar branches from the deep circumflexa ilei, the external circumflex and gluteal arteries.

273. 4. The *profunda femoris* may be considered as the proper nutritious vessel of the thigh, its branches being distributed to it exclusively, whilst the femoral artery passes onwards to supply the leg and foot, giving off very few branches (and these insignificant ones) whilst it corresponds with the femur. In this view of the destination of these vessels, the terms applied to them by Murray seem sufficiently appropriate. The short trunk intervening between

Poupart's ligament and the origin of the profunda, he names *femoralis communis*, the continuation of the vessel as it passes along the thigh, *femoralis superficialis*, and its deep-seated branch, *femoralis profunda*. The profunda arises from the external and posterior surface of the femoral artery, usually from an inch and a half to two inches below Poupart's ligament. It at first inclines outwards in front of the iliacus muscle, but soon changes its direction, running downward and backwards behind the femoral artery. Opposite the junction of the upper with the middle third of the femur, the profunda passes beneath the adductor longus muscle, and inclining outwards to the linea aspera of the femur, soon divides into its terminal branches, which pass between that ridge of bone and the adductor magnus, to reach the posterior part of the thigh, where they are distributed to the flexor muscles. The trunk of the profunda in this course lies at first on the psoas and iliacus muscles, after their junction, then on the pectineus and adductor brevis, finally on the adductor magnus. In the first part of its course it is separated from the femoral artery by the profunda and femoral veins, and by a quantity of cellular tissue, in which all these vessels lie embedded; lower down the adductor longus is interposed between them. In addition to a number of nameless, and merely muscular branches, the profunda gives off the following, which deserve particular notice.

a. The *external circumflex* branch arises from the profunda, whilst it rests on the iliacus muscle, and after passing outwards for a short way beneath the sartorius and rectus muscles, and through the divisions of the anterior crural nerve, it gives off branches, which may be divided into three sets, from the directions which they take. The first continue transversely outwards in the course of the vessel, and after passing over the crureus, pierce the vastus externus, so as to get between it and the bone just below the trochanter major, and so reach the posterior side of the thigh, where they anastomose with the internal circumflex, the gluteal and sciatic arteries. The ascending branches pass upwards beneath the sartorius and rectus, and finally under the tensor vaginæ femoris, where they communicate with the terminal branches of the gluteal artery. The descending set pass outwards and downwards upon the extensor muscles, covered by the rectus. They are usually three or four in number, some of them being of a considerable size; most of them are distributed to the muscles on the fore-part of the thigh, but one or two can be traced as far as the knee, where they anastomose with the superior articular arteries (internal and external) of the popliteal, and with the anastomotic branch of the femoral.

b. The *internal circumflex* branch arises from the inner and posterior side of the profunda, and turns directly backwards between the pectineus and adductor brevis, so that only a small part of it can be seen without disturbing these muscles. On reaching the tendon of the obturator externus muscle, which in a manner guides it to the posterior part of the thigh, it divides into two branches, or rather sets of branches. One of these ascends, and is distributed partly to the external obturator muscle, where it anastomoses with the obturator artery, partly to the adductor brevis and gracilis; the other branch passes backwards above the trochanter minor, and appears on the posterior aspect of the limb, between the quadratus femoris and adductor magnus, where it anastomoses with the sciatic and superior perforating arteries. When this transverse branch of the internal circumflex arrives opposite the hip joint, it sends into it, through the notch in the acetabulum, an articular vessel, which passes beneath the transverse ligament, and after supplying the adipose substance in the depth of the articulation, is guided to the head of the femur by the round ligament. In some instances this vessel is derived from the obturator artery, sometimes the joint receives one from both.*

c. The *perforating* branches, so called from piercing the adductor muscles, are three or four in number. The *first* passes backwards between the pectineus and adductor brevis, sometimes through the fibres of the latter, and finally through the adductor magnus, after which it immediately divides into branches, which are distributed to the adductor magnus, the biceps, and gluteus maximus, communicating with the sciatic and internal circumflex arteries. The *second*, considerably larger than the first, always passes through the adductor brevis and magnus, after which it divides into an ascending and descending branch; the former, passing up on the adductor, supplies the posterior muscles, and anastomoses towards the great trochanter, with the circumflex and sciatic arteries; the latter descends, and is distributed to the flexor muscles, where it communicates with the terminal branches of the profunda. A branch of this vessel usually enters the medullary foramen of the femur. The *third* perforating artery passes back from the profunda, when it has got under cover of the adductor longus, pierces the adductor magnus, and like the others is distributed to the flexor muscles.

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* Harrison, *Surgical Anatomy of Arteries*, vol. ii. p. 168.

274. The profunda, after having given off these different vessels, becomes considerably diminished in size, and passes backwards close to the linea aspera, where it divides into branches, some of which are distributed to the short head of the biceps, the rest to the other flexor muscles. These terminal branches do not pass to their destination exactly in the same way as the perforating set do; the latter pierce through the fibres of the adductors, about an inch, or a little less, from their insertion, the former pass close to the linea aspera, between it and some tendinous fibres which arch over the vessels, and protect them from compression by the muscle. At these points the muscle is attached, not to the bone, but to the tendinous fibres just referred to. A similar provision will be found in several other parts of the body, for instance, where the profunda humeri passes beneath the triceps, &c.

It may be observed, that considerable variety obtains in the mode of origin of the branches of arteries here described. As Meckel justly observes, the varieties in the arterial system are not less numerous than those of the venous, which is not generally supposed to be the case. But as these branches are intended to carry on the collateral circulation, after the main vessel has been obliterated, their course and distribution are usually regular and uniform. The femoral artery in its course along the thigh gives branches to the contiguous muscles, but none of them merit a particular name or description. Close to its termination a small but regular branch arises from it,—

The *anastomotic artery* (*ramus anastomoticus*) descends from the femoral, as it is about to pass into the popliteal space, in a line continuous with that of the trunk, from which it arises. It pierces the tendinous fascia which binds down the femoral artery, and gives off two or three branches, whilst the vessel itself passes down to the inner condyle, guided by the prolonged tendon of the adductor magnus, and there anastomoses with the internal articular artery. The branches pass obliquely outwards through the substance of the vastus internus, and communicate with the long descending branches of the external circumflex artery.

Dissection and operations.—In the first place, let the knee be slightly bent and the limb rotated outwards. And as in this position the course of the femoral artery is indicated by a line extended from midway between the anterior superior spine of the ileum, and the pubic symphysis, to the lower border of the patella, the first incision through the skin should be made to the same extent, and in the same direction. In order to reflect the integuments with facility, a second incision may be made transversely at the junction of the upper, with the middle third of the thigh; and finally, another in the same direction opposite the termination of the femoral artery. The flaps of skin thus formed are to be dissected back, so as to expose the fascia lata. When the superficial epigastric and circumflexa ilei arteries have been traced, the fascia may be divided to the same extent as the skin, so as to expose the muscles, which are to be dissected carefully. The internal pudic branches will be found running inwards on the pectineus; the external circumflex outwards beneath the sartorius and rectus, its trunk affording a clue to its different branches, which can be traced without any difficulty after the vessel has once passed the crural nerves. The dissection of the femoral artery in the upper part of the thigh, requires some care, as it is embedded in a quantity of cellular tissue, and gives off its more important branches. The profunda and femoral veins also, which here lie close to it, together with their different branches, pour out blood when divided, which embarrasses the young dissector. Hence it often becomes necessary to divide the veins, and remove them, after which the parts may be spunged and the dissection proceeded with. Before this measure is resorted to, the sheath of the vessels should be laid open, and the relative position of the vein and artery considered attentively. In the middle third of the thigh, little more is necessary in order to exhibit the vessel, after the fascia has been removed, than to turn the sartorius outwards; the course of the artery is then readily perceived, though it is bound down by the firm membrane already noticed, as passing across it from the adductors to the vastus. The relation of the saphenus nerve and the vein to the femoral artery, should be noted carefully, and its depth from the surface considered, which will at once point out the difficulty of cutting down upon, and tying it in this situation, and the comparative facility with which it can be reached in the upper third of the thigh. When the femoral artery has been sufficiently examined, attention should be directed altogether to the profunda and its branches. To expedite the dissection the femoral artery and vein, and also the deep profunda veins, had better be removed; and if after this, the adductor longus be detached from its origin at the pubis, and reflected outwards over the vastus, the profunda artery will be fully exposed. Little difficulty can occur in tracing the external circumflex branch; but as the internal one sinks deeply between the muscles, it becomes necessary to divide the pectineus at its origin, and turn it outwards on the thigh, after which the artery can be traced as far as the neck of the femur; its terminating branches can be seen only when the posterior part of the thigh has been dissected. In this dissection the crural nerve and its branches should be attended to. They will be observed spreading out into a lash of filaments, which are distributed to the different muscles on the front and inner side of the thigh, whilst a few descend along the course of the artery.

When the subject is turned on its face, in order to dissect the posterior part of the limb, an incision may be carried through the skin from midway between the tuber ischii and trochanter major, to the middle of the popliteal space. This may be met by two transverse incisions, similar to those made on the fore-part of the thigh. When the flaps of integument are reflected, and the fascia examined, the latter may be divided to the same extent, which will expose the flexor muscles. These may be merely divided and drawn aside, after which the distribution of the perforating branches can be readily examined, as they lie on the adductor magnus, before their final termination. The anastomosis of the circumflex arteries shall be considered after we have described the gluteal and sciatic arteries. As the incision through the integument here indicated corresponds with the course of the great sciatic nerve, it may be well to observe its relation and connexions whilst prosecuting the dissection of the arteries.

The femoral artery may be tied on the superior or middle third of the thigh; the former situation is now universally preferred, because the operation in the latter is considerably more difficult of execution, without securing any equivalent advantage. The limb being placed in the position pointed out at the commencement of these remarks, an incision is made through the integuments, beginning two inches below the middle point of Poupart's ligament, and carried perpendicularly downwards for three inches, or a little more, in a muscular fat subject. Previously to commencing this incision, it may not be amiss to place a scalpel, or a probe, along Poupart's ligament, and mark upon it the middle point; if the external end of the instrument be depressed, so that it should lie horizontally across the thigh, the incision through the integument should be made so as to form with the instrument, so placed, a right angle. This suggestion is intended only for those who are about to perform the operation on the dead subject, or who may be planning the execution of it. The fascia lata being exposed, a small part of it should be pinched up with the forceps, and cut across, so as to form a small opening, into which a director is to be passed, in order that the fascia may be safely divided upon it. The sheath of the vessels is thus brought into view; a small part of which should be raised by the forceps and divided, the knife being held in the horizontal position. The vein in this situation will be found behind, and a little to the inner side of the artery; on which account, in carrying the needle round the latter, its point is to be directed from within outwards, and cautiously insinuated between them, its surface being held close to the artery. Some difficulty is generally experienced in effecting this step of the operation. The point of the needle is said to be hitched on "some tough cellular membrane," which is pushed onwards, and requires to be divided before the needle can be fairly protruded. This resistance is owing to the sheath of the vessels, now loose after its division, and readily caught into a fold by the point of the instrument. In operating on the dead subject, this impediment is readily removed, by pinching up the external flap of the sheath, and holding it tight with the forceps, whilst the needle is passed round the artery. The nerves which here lie external to the sheath, will by the same expedient be held out of the way. The ligature of the carotid artery is facilitated by the same means. Would such a measure be advisable in operating on the living? It is not altogether undeserving of attention.

275. The *popliteal artery* (*portion poplitée de la crurale*, Chauss.) is that part of the arterial trunk that extends from the opening in the adductor magnus, to the lower border of the popliteus muscle, being continuous superiorly with the femoral, and inferiorly with the anterior and posterior tibial arteries, into which it divides. The direction of the vessel is downwards and a little outwards, running through the centre of the popliteal space. In this course the vessel rests superiorly on the flat surface of the femur, then on the posterior surface of the knee joint, and finally on the popliteus muscle. Its posterior surface is covered for some way by the semi-membranosus; in the ham it is covered only by the skin, fascia, and a quantity of adipose matter in which it is embedded, but lower down it is concealed by the gastrocnemius. On either side of it lie the hamstring muscles above, and the heads of the gastrocnemius below. The artery is accompanied by the popliteal vein, and the sciatic nerve, the vein being posterior, and a little external to it, the nerve still more posterior and external, that is to say, lying nearer to the skin and to the head of the fibula. The popliteal artery gives off five articular branches, two above and two below the joint, and one which passes into it, and also some muscular branches to the gastrocnemius, hamstrings, &c.

1. The *superior articular* arteries; of these the *internal* one turns round the inner side of the femur, just above the inner condyle, and divides into two branches, one of which supplies the lower part of the vastus internus, the other ramifies in front of the knee joint: 2, the *external* one passes outwards above the corresponding condyle, divides into branches, some of which are lost in the vastus muscle, whilst the rest reach the front of the articulation. 3. The middle or *azygos* branch passes from the anterior surface of the popliteal artery, pierces the posterior ligament of the joint, and divides into minute ramifications for the supply of the crucial ligaments and the other structures within the articulation. 4. The *internal* branch of the inferior articular arteries passes downwards and inwards below the corresponding tuberosity of the tibia, lying between the bone and the internal lateral ligament; its branches ramify on the anterior and inner part of the joint, as far as the patella and its ligament: 5, the *external* one takes its course outwards under cover of the external head of the gastrocnemius in the first instance, and afterwards under the external lateral ligament of the knee, and the tendon of the biceps muscle. It thus reaches the fore-part of the joint, and near the border of the patella divides into branches, of which one descends along the ligament of the patella to communicate with the inferior articular artery of the opposite side, and with the recurrent branch from the anterior tibial; the other ascends and anastomoses with the superior articular arteries. In a well injected limb, the four articular branches form at the front and sides of the joint a complete mesh by their ramifications, all of which freely communicate with one another, and several of them may be traced into the substance of the bones through the foramina on their surface.

Dissection. The subject being turned on its face, an incision should be made through the skin, along the middle of the popliteal space, extending from the lower third of the thigh, as far as the upper fourth of the leg, which corresponds with the length of the popliteal artery. A transverse incision should be made right across this at each extremity; the flaps thus marked out being reflected, and the fascia exposed, this membrane is to be divided and reflected in the same manner. By these means the muscles bounding the popliteal space are exposed. The interval which they enclose is of a quadrilateral figure, two sides being formed by the hamstring muscles diverging to their insertions, and two by the heads of the gastrocnemius, converging to their point of union. Through the centre of this space, from its superior to its inferior angle, runs the popliteal artery; but to expose it fully, the mass of adipose matter by which it is concealed, must be dissected away, in order that its relation to the vein and nerve may be clearly discerned. To follow it up in the superior part of its course nothing more is necessary than to draw aside the flexor, or hamstring muscles, as they are merely connected by some cellular tissue, which retains them in apposition with one another. But as the lower part of the vessel is covered by the gastrocnemius, it will answer all purposes to divide the inner head of that muscle near the condyle, and then reflect and carry it outwards, which will expose it as far as its bifurcation.

276. The *posterior tibial* artery, (*tibialis postica*) is situated along the posterior part of the leg, between the superficial and deep muscles, being firmly bound down to the latter by the deep fascia. It extends from the lower border of the popliteus muscle, where it is continuous with the popliteal artery, (of which it may be regarded as the continuation, from its direction and course) as far as the inner border of the calcaneum, where it terminates, by dividing into the plantar arteries. The course of the vessel is obliquely downwards and inwards, being placed above, midway between the bones of the leg, and below, between the inner ankle and the prominence of the heel. Its anterior surface rests successively on the tibialis posticus, the flexor longus digitorum, and inferiorly, for about two inches, on the tibia, separated from it by some cellular tissue; posteriorly it is covered by the gastrocnemius and soleus, (the deep fascia being interposed) and farther down, by the fascia of the leg, as it is stretched from the tendo Achillis to the inner border of the tibia. On each side lie its accompanying veins, and along its external, or fibular side, runs the posterior tibial nerve. It will be recollected, that in the hollow between the internal malleolus and the calca-

neum, run three tendons, as well as the posterior tibial vessels. Their relative position may be stated as follows:* the tibialis posticus and flexor longus digitorum run close to the inner malleolus; a quarter of an inch behind these is the tibial artery, the nerve being a little posterior to it, and finally about half an inch farther back towards the heel, is the tendon of the flexor longus pollicis. In its course along the leg, this artery gives several branches to the contiguous muscles, particularly to the tibialis posticus and the long flexors. In the superior third of its extent, a considerable branch (*nutritia magna tibiæ*, Soemm., Murray) passes forwards to the tibia, and then, by an oblique course through the nutritious foramen in that bone, reaches the medullary membrane, on which its branches ramify.

277. The *peroneal artery* (*arteria peronea*) is situated deeply along the posterior part of the leg, taking the direction of the fibula; hence it is sometimes called *fibular*. It arises from the posterior tibial, from an inch to two inches below the lower border of the popliteus muscle, and descends almost perpendicularly towards the external ankle. Running for a while parallel and on the same plane with the posterior tibial artery, it lies on the tibialis posticus muscle, and is covered for the same distance by the soleus; as it descends, it inclines outwards to the fibula, and corresponds with the angle of union between it and the interosseous ligament. In this part of its course it is concealed from view by the flexor longus pollicis, to which it gives branches, as well as to the adjacent muscles, and also one to the substance of the fibula (*arteria nutritia fibulæ*). On reaching the lower extremity of the interosseous ligament, which is about two inches, or a little more, above the external ankle, the artery usually divides into two branches, named, from their situation, anterior and posterior peroneal.

a. The *anterior peroneal* branch passes forwards through the aperture in the interosseous ligament, and so reaches the forepart of the leg; it then descends along the border of the peroneus brevis, and sends several branches outwards to the external ankle, which anastomose with the external malleolar branch of the anterior tibial, and forwards on the dorsum of the foot, to communicate with the dorsalis pedis branch of the same artery. Some of its ramifications also extend to the outer border of the foot, where they communicate with the external plantar and posterior peroneal arteries.

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* See Harrison, *Surgical Anatomy of Arteries*, vol. ii. p. 189.

b. The *posterior peroneal* branch follows the course of the trunk, of which it is an offset, running behind the external ankle, to reach the outer surface of the calcaneum. On arriving at the latter situation, it divides into several branches, some of which pass backwards to anastomose with the posterior tibial, others downwards to the border of the foot, and terminate in the muscles of the little toe, the rest forwards on the tarsus, communicating with the anterior fibular branch, and with the tarsal branches of the anterior tibial.

278. The size and distribution of the fibular artery vary considerably in different instances; in some the posterior tibial is wanting, the popliteal appearing to divide into anterior tibial and fibular, the latter being double its usual size. In such cases, when the vessel reaches the lower part of the leg, it sends inwards a considerable branch, which taking the course of the posterior tibial artery round the inner ankle, terminates in the plantar branches. In other instances the anterior tibial artery is very small, and its dorsal branch necessarily too diminutive to carry on the circulation on the foot. The anterior fibular branch is then of considerable size, and supplies its place.

When the posterior tibial artery reaches the hollow of the calcaneum, and gets under cover of the internal annular ligament and the origin of the abductor pollicis, it divides into the two plantar arteries, named, from their position, internal and external.

1. The *internal plantar* artery, much smaller than the other, turns directly forwards, so as to form, when the body is in the erect position, a right angle with the vessel from which it arises.

Placed at first above the abductor pollicis, and afterwards between it and the short flexor, it gives branches to both, and also sends a branch, which inclines towards the inner border of the foot, and communicates with some of the dorsal arteries. On reaching the extremity of the first metatarsal bone, the internal plantar artery, considerably diminished in size, terminates by running along the inner border of the great toe, anastomosing with its digital branches. The direction of the artery corresponds with that of the line which separates the internal from the middle set of plantar muscles.

2. The *external plantar* artery, in size and direction, appears to be the continuation of the external tibial. In its course it at first inclines outwards and forwards, to reach the base of the fifth metatarsal bone, where it changes its direction, arching inwards across the foot, to gain the interval between the first and second metatarsal bones, where it receives the communicating branch from the dorsal artery, which completes the plantar arch. The vessel first passes between the calcaneum and the abductor pollicis, then between the flexor brevis digitorum and flexor accessorius; as it turns forwards it lies in the interval between the former muscle and the abductor of the little toe, corresponding with the line separating the middle from the external portion of the plantar fascia; but its transverse part is deeply covered by the flexors of the toes and the lumbricales. The external plantar artery gives off during its course branches in every direction. Of these some pass outwards over the border of the foot, and anastomose with the dorsal arteries, others go back to supply the parts in the hollow of the foot, and several down to the fascia, integument and subcutaneous cellular substance; these are too irregular to admit of being named or described; but from its superior and anterior surfaces, branches are given off, which deserve notice. The *perforating branches, (rami perforantes)* three in number, pass upwards between the metatarsal bones, through the posterior extremities of the dorsal interosseous muscles, and on reaching the dorsum of the foot, inosculate with the metatarsal arteries. The *digital branches* (*rami digitales*) are four in number, and from the order in which they arise from the arch, they are named first, second, &c. *a.* The *first* digital branch curves outwards, to gain the fibular border of the fifth metatarsal bone; for it will be re-

collected that the most external part of the plantar arch corresponds with the fourth metatarsal space. In its course this vessel crosses under the abductor of the little toe, and then runs along the border of its phalanges, on the last of which it terminates: *b*, the *second* digital branch, passes forwards along the fourth metatarsal space, and at the cleft between the toes divides into two twigs, which take the contiguous borders of the fourth and fifth toes, and end on their third phalanges: *c*, the *third* digital branch, is similarly disposed of on the third and fourth toes: and *d*, the *fourth*, on the second and third. Near the point of bifurcation each digital artery sends upwards through the corresponding metatarsal space a small branch, which communicates with the digital branches of the metatarsal artery. These are called the *anterior perforating* branches. The digital arteries, which, from their relation to the phalanges, are sometimes called collateral, at their final termination incline towards one another, and form arches by inosculation, from the convexity of which minute vessels pass forwards to the extremities of the toes.

279. The *anterior tibial artery* (*tibialis antica*) is placed deeply along the fore part of the leg, extending from the division of the popliteal, to the bend of the ankle, from whence it is prolonged to the interval between the first and second metatarsal bones, under the name of the dorsal artery. Its course may be marked out by a line drawn from the inner border of the head of the fibula to the middle of the ankle joint. At starting, it turns horizontally forwards to reach the anterior surface of the interosseous ligament. In doing so, it necessarily passes between the heads of the tibialis posticus muscle, and through the interval between the bones left unclosed by that membrane. In its course it rests for two thirds of its extent on the interosseous ligament, and for the rest, on the anterior surface of the tibia. In the upper part of its extent it is deeply seated, and in a manner overlapped by the tibialis anticus and extensor longus digitorum; the former being on its tibial, the latter on its fibular side. Lower down it lies between the extensor pollicis and tibialis anticus; but as, towards the ankle, these

muscles incline inwards, the one to the tarsus, the other to the first metatarsal bone, whilst the artery continues directly onwards, it necessarily passes beneath the extensor pollicis, and is placed between the tendon of this muscle and that of the extensor communis digitorum. In this situation it is covered only by the skin and fascia of the leg. The anterior tibial artery is accompanied by two veins (*venæ comites*); the anterior tibial nerve lies to its fibular side for some way, as being derived from the peroneal nerve, but usually inclines in front of it as it descends. Its branches are as follows:

a. Small muscular branches to the tibialis posticus, as it passes between its heads: *b*, on reaching the front of the leg, it sends upwards a pretty large and regular branch, (*arteria recurrens*) which passes through the fibres of the tibialis anticus, and soon divides into several ramifications, which on the lateral and fore parts of the knee joint, anastomose with the inferior articular arteries of the popliteal: *c*, in its progress downwards between the extensor muscles it gives on each side several muscular branches: *d*, near the ankle joint the two *malleolar arteries* are given off; the *internal* one passing beneath the tendon of the tibialis anticus, reaches the inner ankle, and ramifies upon it, supplying the surrounding textures, and communicating with branches of the posterior tibial; the *external* malleolar artery bears a similar relation to the outer ankle; having passed under the tendon of the common extensor, it anastomoses with the posterior peroneal artery, and also with some ascending or reflected branches from the tarsal artery.

280. The *dorsal artery* of the foot (*la pedieuse*, Bichat) is the continuation of the anterior tibial, extending from its termination, at the bend of the ankle, to the posterior extremity of the first metatarsal space, where it dips into the sole of the foot, and terminates by inosculating with the plantar arch. Its direction is forwards and inwards, running over the astragalus, the scaphoïd, and internal cuneïform bones; it is covered by the skin and fascia, and lies between the tendons of the extensor proprius pollicis and extensor com-

munis. In its progress the following branches pass off from the dorsal artery:

a. The *tarsal branch* (*arteria tarsea*) inclines outwards, lying close to the tarsal bones, and covered by the extensor brevis. Opposite the head of the fibula it communicates with the posterior fibular and external malleolar arteries, after which it continues onwards beneath the peroneus brevis, to the external border of the foot, where its final ramifications terminate: *b*, the *metatarsal* branch, so called from its being placed over the heads of the metatarsal bones, arises from the dorsal artery, as it is about to sink into the interosseous space, and thence arches outwards under cover of the extensor tendons, and terminates at the external border of the foot. From the arch small branches pass off to supply the surrounding structures; but from its convexity, which is turned forwards, three branches proceed along the interosseous spaces, supply the muscles which fill them, inosculate with the perforating arteries from the plantar arch, and finally, on reaching the cleft between the toes, divide into two small branches which supply the contiguous borders of the lesser toes. This artery presents many varieties in its size as well as in the number of its branches; sometimes the interosseæ are derived from the tarsal artery: *c*, when about to pass down into the sole of the foot, the dorsal artery sends forwards, on the first metatarsal bone, a branch (*dorsalis hallucis*) which when it arrives at the fissure between the first and second toes, divides into two branches for the contiguous borders of the two first toes: *d*, the *communicating* branch, (*arteria communicans*) or rather the termination of the dorsal artery, passes between the heads of the first dorsal interosseous muscle into the sole of the foot, where it inclines outwards and inosculates with the plantar arch. From their point of union a considerable vessel is sent onwards along the first metatarsal space, which, when it reaches the digital extremity of the two first metatarsal bones, divides into branches, which diverge as they apply themselves to the adjacent borders of the phalanges of the two first toes.

Dissection and operations.—When describing the method of exposing the popliteal artery, it was stated that this could be effected by merely dividing the inner head of the gastrocnemius, and turning the corresponding venter of it somewhat outwards. A small part of the posterior tibial artery, which is the continuation of the popliteal, is at the same time brought into view: but as the rest of it lies deeply beneath the soleus, this muscle must be detached wholly or in part, in order to trace the course of the vessel. As the vessels are here bound down to the deep-seated muscles by the deep fascia, and as that membrane exerts an important influence on the progress of operations executed on these arteries, it is advisable to leave it untouched, whilst the superficial muscles (those of the calf of the leg) are being removed. This end can only be attained with facility by proceeding with the dissection of the muscles from below upwards. An incision may with this view be made through the strong external fascia of the leg, along the borders of the tendo Achillis. If the tendon be then drawn backwards, and held on the stretch, the deep fascia will be readily exposed, from the ankle, as far as the belly of the soleus muscle. When this is effected, there can be no difficulty in detaching the muscle from the tibia and fibula, as the fascia serves as a guide, indicating the line of separation between the superficial set which are to be removed, and the vessels and deep-seated muscles that are to be left untouched. In the lower part of its course, where it runs in the depression between the inner ankle and the heel, the artery can be exposed and secured without much difficulty. Towards the middle of this interval, but nearer the prominence of the inner ankle than that of the heel, by a finger's breadth, the vessel may be observed to pulsate, if the foot be extended so as to relax the fascia and integuments. An incision should be made about two inches and a half in length, beginning near the inner border of the tendo Achillis, and extended downwards and forwards over the point just indicated. The integuments being thus divided, and the strong fascia of the leg exposed, it is in the next place to be laid open to the same extent, after which a deep fascia comes into view, being a continuation of that above described, as binding down the deep muscles and vessels. A small piece of this being pinched up by the points of the forceps, it is cut through so as to allow a director to be inserted beneath it, on which it is to be divided. The vessels are thus laid bare, so that the artery, after having been separated from the nerve and veins with the same precautions, as in other situations, may be readily tied, the point of the needle being directed from below upwards and inwards towards the ankle, to avoid the nerve.

In the interval between the lower part of the calf of the leg and the inner ankle, the artery may be exposed in the following way: An incision should be made parallel with the inner border of the tendo Achillis, for about the same length, and through the same structures (the skin and two layers of fascia) as in the preceding operation. This will bring the artery into view.

Few operations on arteries, probably none, present more difficulties than that of tying the posterior tibial, while it is under cover of the soleus and gastrocnemius. The tibial origin of the former must be detached from the bone; and if, during this step of the operation, the deep fascia be torn, or the muscles rendered in any way confused, there remains no guide to the situation of the artery. In order to relax the muscles as much as possible, the knee must be slightly bent, and the foot extended so as to elevate the heel. If the limb be then placed on its outer side, and the knee supported, the seat of operation will be fairly brought into view. The incision through the skin must be very long, as the vessel lies so deeply; it may vary from four to five inches, according to the thickness of the muscles. It is usually directed to be made along the inner border of the tibia, so as to expose the margin of the gastrocnemius. In doing this the saphena vein can be easily avoided, as its course is quite apparent. When the soleus is exposed, its border is to be detached from the tibia, proceeding from below upwards, so as, if possible, to get a clear view of the deep fascia. If this be once obtained towards the lower part of the incision, a director can, without much difficulty, be insinuated between the membrane and the muscle, preparatory to the division of the fibres of the latter. When, by means of a retractor, the muscles are drawn back, so as to open the wound, its breadth will be found diminished by the posterior border of the incision in the integument; for it will be recollected, that its direction coincided, in the first instance, with that of the border of the muscle, where it is attached to the bone; but it will no longer do so when the muscle is drawn backwards. In other situations, where deep incisions are required, both margins of the wound can be held aside by the retractors, but here the posterior one only admits of their application, as the other coincides with the tibia. The necessity of some change in the line of the first incision is obviously suggested by these facts; and we believe that M. Lisfranc makes his incision rather obliquely, its direction being from above downwards and backwards, so that when the muscles are retracted, their border may coincide with that of the skin.

The dissection of the plantar arteries includes that of the sole of the foot. When the thick skin and cellular texture are removed, and the plantar fascia fully exposed, the external plantar artery may be readily exposed by cutting through a few fibres of the fascia, along the depression which separates the middle from the external portion of it; for when it has got on a line with the head of the fifth metatarsal bone, the vessel is almost superficial, though in the rest of its extent it is covered deeply by the muscles. The internal plantar artery can be laid bare merely by dividing the thin membrane which covers the abductor pollicis, and, turning aside the external border of that muscle. When the plantar fascia and flexor brevis are detached and reflected from the calcaneum, the vessels can be easily traced in the rest of their extent.

It has been observed that the course of the anterior tibial artery, and that of its continuation, the dorsalis pedis, may be marked out by a line drawn from the inner border of the head of the fibula, to the middle of the bend of the ankle, and thence continued onwards to the first metatarsal space. To expose the vessels, an incision should be made through the skin, corresponding with this line. Its commencement may in the next place be crossed by another, extending from the head of the fibula to the inner tuberosity of the tibia; a similar transverse incision is to be made at the ankle, and to evert the skin conveniently, a third will be found necessary about midway. The flaps of integument being everted, the one inwards on the tibia, the other outwards over the fibula, and the fascia exposed, the intervals between the muscles at once become apparent, where their tendons shine through the fascia. This membrane should now be divided in the same extent and direction as the skin, and the artery will be brought into view by separating the muscles, which can be done without the least difficulty by proceeding from below upwards.

The dorsal artery, being placed between the tendons of the extensor proprius pollicis and extensor communis, and uncovered by any structure, except the skin and fascia, may be laid bare by an incision carried along the external, or fibular border of the tendon of the extensor proprius, for about an inch a half, or two inches. Above the bend of the ankle the incision must be somewhat longer, say two inches and a half, and the vessel will be found on the tibia, lying to the inner border of the extensor proprius.

281. The *internal iliac artery* (*iliaca interna, hypogastrica; la pelvienne,* Bichat, Chaussier) in the fœtus, both from its direction and size, appears to be the continuation of the common iliac trunk. It is nearly double the size of the external iliac artery, but in the adult the relation in this particular is reversed, the external iliac being much larger. As the vessel in the fœtal state differs from that in the adult subject, so materially in length, relations, &c., it becomes necessary to describe its condition in the former, previously to considering its course and distribution in the latter. When the vessels in the fœtus are injected, (part or the whole of the umbilical cord remaining attached) it will be found, that the internal iliac artery proceeds, from the point at which the common trunk divides, (*sacro-iliac symphysis*) forwards and a little downwards, to reach the side of the bladder. In this course the artery descends very little, as the body and fundus of the bladder project into the abdomen in early life. Guided by the side and fundus of the bladder, it reaches the inner surface of the parietes of the abdomen, along which it ascends to the umbilicus, converging to the vessel of the opposite side. When arrived at that aperture the two arteries come into contact with the umbilical vein, round which they coil in a peculiar manner, until they reach the placenta, in the spongy texture of which their branches ramify, until they become capillary. To that part of the vessel which intervenes between the sacro-iliac symphysis and the side of the bladder, the term internal iliac, or hypogastric, can in strictness be applied, the remainder thence onward through the umbilicus to the placenta, is the proper umbilical artery,

and is usually enumerated as one of the peculiarities of the fœtal circulation. In the first part of its course the vessel lies along the margin and side of the pelvis, covered by the peritonæum, then between that membrane and the side of the bladder; and finally between it and the fascia transversalis, which separates it from the rectus muscle and its sheath. After birth, when the placental circulation is no longer carried on, the umbilical arteries gradually contract, become impervious, and reduced to the form of mere ligamentous cords, extending from the side of the bladder to the umbilicus. The remaining part, which still continues pervious, presents a diminution in size proportioned to the decrease in the quantity of blood circulated through it, as it thenceforth has to supply only the parts within the pelvis, and the muscles on its exterior.

282. In the adult the internal iliac artery is a short, stunted trunk, extending from the sacro-iliac symphysis to the sacro-sciatic notch, opposite to which it may be said to terminate, by dividing into several branches, for none of them can be regarded as a continuation of it, or as following its course. The external side of the artery, just at its origin, is in contact with the inner border of the psoas muscle; lower down it rests against part of the sacral plexus. Behind it, is situated the internal iliac vein, and the communicating branch, which passes from the lumbar to the sacral plexus; in front it is crossed by the ureter, which separates it from the peritonæum. When the depth at which this vessel is situated is duly considered, as well as its close connexion with the different parts here enumerated, we can form some idea of the difficulty of passing a ligature round it, in the living subject, without including the nerve, or injuring the vein. Its branches, though constant and regular in their existence and general distribution, still vary much in their origin. They consist of an internal set, rather small and variable, which are distributed to the parts within the pelvis, viz. the surface of the sacrum, the rectum, bladder,

uterus, and vagina; these shall be described when we treat of the organs they supply. The rest, consisting of the larger vessels, which consist of the branches sent to the muscles within and upon the pelvis, we shall describe in this place. They are as follows: the ileo-lumbar, obturator, gluteal, and sciatic arteries.

283. The *ileo-lumbar artery* (*l'iliaco-musculaire*, Chauss.) resembles the lumbar branches of the aorta in direction and distribution. It passes outwards, beneath the psoas muscle and external iliac vessels, to reach the margin of the iliac fossa, where it divides into two sets of branches. Of these, one passes upwards, ramifying in the psoas and quadratus muscles, where some of them communicate with those of the last lumbar arteries, whilst others enter the intervertebral foramina, and supply the parts lodged in the vertebral canal. The rest of its branches turn downwards and outwards, either in the substance of the iliacus muscle, or between it and the surface of the ileum. Some of these reach the crista and spine of that bone, where they anastomose with the circumflexa ilei, and, if followed with attention, some can be traced forwards through the abdominal muscles, which they supply, and in which they communicate with the external branches of the epigastric artery.

284. The *obturator artery* (*la sous pubio-femorale*, Chauss.) arises from the internal iliac, or one of its large branches, (gluteal or sciatic) and not unfrequently from the epigastric. The course and length of the internal, or pelvic portion of the vessel, will vary materially in these cases; the external, or femoral, is usually uniform. According to J. Cloquet, who noted its distribution in more than two hundred instances, the number in which it arises from the iliac, as compared with that from the epigastric, may be stated as three to one. When the obturator artery arises from the internal iliac, it passes forwards close to the obturator internus muscle, and a little beneath the nerve of the same name, with which it gradually comes into contact.

Both pierce the pelvic fascia, pass through a cellular interval between the pubic and ischiatic portions of the obturator muscle, and finally appear at the top of the thigh, after having made their way through the oval aperture in the thyroïd or obturator membrane. In this course the nerve lies above the artery, both being placed between the pelvic fascia and peritonæum, as they run along the inner side of the pelvis. But when it arises from the epigastric artery, it has to pass downwards and inwards into the pelvis, in order to reach the thyroïd foramen; and in doing so, its course must lie along the margin of the crural ring, and must be placed close to some part of the neck of the hernial sac, should a portion of intestine be protruded through that aperture. If the obturator artery arises near the origin of the epigastric, or by a short trunk, common to it and that vessel, it will be placed across the external side of the crural ring; but if it starts from a point higher up, as it has to incline inwards whilst descending into the pelvis, it will be found along the superior and internal border of the ring, and therefore almost surrounding the neck of the sac. This, however, is rather an unusual occurrence; Breschet* appears to have met only a single instance of it. When the obturator artery has reached the thigh, it is supported on the external obturator muscle, and covered by the pectineus; it soon divides into two branches, one external, the other internal. *a.* The *external* branch inclines downwards and outwards to the tuber ischii, sending off branches, some for the supply of the obturator and quadratus muscles, whilst one or two, in some instances, reach the notch in the acetabulum, through which they pass, and are distributed to the hip joint. *b.* The *internal* branch passes downwards between the adductors, supplies them as well as the pectineus and gracilis, and communicates with branches of the internal circumflex artery.

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* THESES *presentées et soutenues publiquement devant les Juges du Concours*, Paris, 1819.

285. The *gluteal artery* (*la fessière*, Chauss.) inclines downwards and outwards, so as to reach the border of the sciatic notch, beneath which it turns, in order to appear on the dorsum of the pelvis. Its trunk will be found, accompanied by the gluteal vein and nerve, in the interval between the contiguous borders of the gluteus medius, and pyriformis muscles, but it instantly divides into branches, one of which runs between the gluteus maximus and medius, and is superficial relatively to the other, which is placed between the latter muscle and the gluteus minimus. *a.* The first branch sends off in its course several ramusculi, which are distributed, some inwards (after piercing the tendinous origin of the gluteus maximus) to the side of the sacrum, anastomosing with the posterior branches of the sacral arteries; others pass outwards between the gluteal muscles, which they supply. *b.* The second, or *deep* branch, situated between the gluteus medius and minimus, runs in an arched direction forwards, and may be said to divide into two branches. The superior one holding the course of the vessel from which it arises, proceeds beneath the gluteus medius and tensor vaginæ femoris, towards the anterior spine of the ileum, and anastomoses with the ascending branches of the external circumflex, after having freely supplied the muscles between which it passes. The other branch descends towards the great trochanter, supplies the gluteal muscles, and anastomoses with the internal circumflex.

286. The *sciatic artery* (*arteria ischiadica*) is smaller than the gluteal, and arises somewhat lower down. It occasionally forms a common trunk with the pudic artery, in other instances it gives off that vessel, when it is about to leave the pelvis. Placed for some way upon the pelvic surface of the pyriformis muscle, and the sciatic plexus of nerves, it soon turns backwards beneath the border of that muscle, lodged in the interval between it and the superior gemellus. In this situation it lies in the interval between the

tuber ischii and great trochanter, covered by the gluteus maximus. It gives off several muscular branches, to supply the external rotators on which it lies, as well as the gluteus which conceals it. Two only of its numerous branches have received names, or require a particular notice. *a.* An internal branch, the coccygeal (*coccygea,* Murray) inclines inwards, and pierces the great sacro-sciatic ligament, and so reaches the posterior surface of the coccyx, and supplies the coccygeus and levator ani muscles. *b.* A descending branch (*comes nervi ischiadici,* Murray, Harrison) runs downwards, accompanying the sciatic nerve, and sends a long branch into its interior, which passes along with it in its course through the thigh. Besides these, some branches, after supplying the upper part of the flexor muscles, anastomose with the gluteal, the circumflex, and superior perforating arteries.

Dissection.—The internal iliac artery, and its branches, whilst within the pelvis, may be shewn merely by detaching the peritonæum and pushing it inwards. If the pelvis be divided at the pubis and sacro-iliac symphysis, a lateral view of them can be obtained, and their course traced, by drawing the rectum and bladder to one side. Outside the pelvis they are all deeply seated, hence it becomes necessary to detach the gluteus maximus from its connexion with the sacrum, and with the sciatic ligament, and reflect it downwards. This enables us to trace, with very little dissection, the sciatic artery, and part of the gluteal; the deep branch of the latter can only be exposed by reflecting the gluteus medius in a similar manner. The muscles may be left attached to their insertions, in order that they may be restored after the dissection is concluded, and the relations of the parts re-considered.

We have made frequent mention of the anastomoses between the different branches of the arteries in the lower extremity. It now becomes necessary to take a general view of them, in order that we may understand the important influence they exert in maintaining the circulation in the limb, when the main trunk is obliterated by an operation, or by disease. It will be recollected, that branches from different directions converge towards the posterior part of the hip joint. The circumflex arteries (internal and external) turn round the shaft of the femur, one from within, the other from without; the gluteal and sciatic arteries run from above downwards, and the superior perforating branches from below upwards, towards the same point. So that if the supply from one quarter be diminished, or cut off, the loss is speedily made up from some other, the vessels taking on an increase of size and action proportioned to the increased demand upon them. This may be termed the ileo-femoral anastomosis. Towards the superior part of the limb, a similar mode of connexion occurs, but by no means so extensive, between the ileo-lumbar artery, and the circumflexa ilei, and again between the latter and the external circumflex on the one hand, and the epigastric on the other.

Round the knee joint a very free communication exists between the four articular arteries, (converging to its fore part) and the recurrent tibial from below, and the descending branches of the external circumflex, from the opposite direction. This may be named the femoro-tibial anastomosis, and if we examine the condition of the vessels, in a well-injected limb, we shall find it connected with the ileo-femoral anastomosis, by the descending branches of the external circumflex artery in front, and by the series of perforating branches behind.

The ankle joint is surrounded by a corresponding distribution of vessels. The posterior tibial artery, and the peroneal, communicate before they proceed to their final destination. In front of the joint, the anterior peroneal branch anastomoses with the tarsal and external malleolar arteries; the latter communicating again with the posterior fibular, whilst the internal malleolar maintains a similar relation with the posterior tibial, or its branches. This freedom of anastomosis between the capillary terminations of different vessels, may be considered as a provision against the consequences that must otherwise follow the obliteration of any of the main vessels of a limb, by an injury, or by operation. If the external iliac artery is tied for an aneurism high up in the femoral, an increased quantity of blood is at once thrown on the internal iliac artery and its branches, which thus become distended and enlarged. Whilst this is taking place, the femoral artery and its branches empty themselves of their blood, forcing it on into the veins, by their contractile power, now that they receive none in their natural course. But after a while they become filled again, and circulate blood, though in a direction exactly opposite to that in which it had previously flowed in them. The capillary terminations of the circumflex arteries receive from those of the gluteal, sciatic, and obturator, the increased current, which is thrown upon them, and convey it thus into the femoral artery below the tumour, for which the operation was performed; and so, in the new order of things, the blood flows from branch to trunk, conducted through the devious route of the collateral vessels, and maintaining the vitality of the limb by what is termed the *collateral circulation.* The anterior and lateral parts of the abdominal parietes, it will be recollected, are supplied by the epigastric and circumflexa ilei arteries. When the regular source of their supply is cut off by the obstruction in the iliac artery, gangrene would speedily supervene, if the circulation were not restored from some other quarter. A recurrence to the anastomoses of these vessels at once reminds us, that the circumflexa ilei artery communicates with the epigastric on the one hand, and the ileo-lumbar on the other, and forms a ready medium of communication between them, when the latter, after the application of the ligature, receives part of the increased current propelled into the internal iliac artery, from which it arises. We need not extend these remarks farther for the present. The anastomoses round the knee and ankle must be sufficiently obvious, from what has been already stated. As, however, the subject is one, not only of deep interest, but of great consequence in a practical point of view, we can scarcely refrain from raising this question, what is the condition of the vessels of a limb which has been the subject of an operation for aneurism? we reply in the words of an eminent authority. "In twelve or fourteen months after a ligature has been applied on the femoral artery, it becomes completely obliterated, as far up as the profunda, and down to the origin of the anterior tibial artery, the remnant of the vessel being a mere cord. The circumflex vessels become enlarged, and convey blood to the rectus, sartorius, and vasti, which had previously been supplied by the femoral. The articular arteries round the knee are also enlarged and tortuous; they receive blood, not from the popliteal, but from the communicating vessels of the profunda." After some general remarks on the effect of ligatures, the description of the limb, which formed the subject of the memoir here referred to, proceeds as follows: "The profunda, which formed the new channel for the blood, was considerably enlarged in diameter, and sent branches larger than usual to the flexor muscles. Just midway on the back part of the thigh, it gave off those branches which became the chief support of the new circulation. The first of the newly established vessels went down to communicate with the superior articular artery, on the inner side of the articulation. Another, guided by the biceps muscle, opened into a muscular branch on the gastrocnemius. Between these, a third vessel, passing along in the course of the sciatic nerve, divided into several branches, communicating with the inferior articular vessels, with the origin of the anterior and posterior tibial arteries, and with some of their muscular branches, in such a way as to form a vascular plexus in the popliteal space. The external circumflex artery was considerably enlarged, and freely supplied the muscles on the fore-part of the thigh. The obturator artery did not appear larger than usual, nor could any enlarged communicating branches be traced between the ischiatic and profunda arteries."*

SECTION III.

THE VEINS AND LYMPHATICS OF THE LOWER EXTREMITY.

287. These two orders of vessels may with propriety be included under one head, not only from the resemblance they present in structure and internal conformation, but also from the close relation subsisting between them in their course and distribution. The veins are the tubes which bring back to the heart the residue of blood remaining after the different functions of secretion and nutrition have been performed by the arteries. The effete and altered blood passes from the capillary terminations of the arteries, into the incipient radicles of the veins, which convey it into the larger branches, from which it is forwarded to the trunks that open into the auricles of the heart. The series of tubes, the aggregate of which constitutes the venous system, has been compared to a tree, the trunk being implanted into the

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* *Dissection of an Aneurismal Limb*, by SIR ASTLEY COOPER. *Med. Chir. Trans.*, vol. ii.

heart, and the branches diffused through the body at large. When we examine this arrangement of vessels, we find two or more minute ramifications uniting to form a branch, and a similar number of branches converging to a vessel of still larger size, until finally all end in one trunk.

288. The veins are usually said to possess only two coats; but, like the arteries, they are also invested by a cellular lamella, which however is more thin and delicate than in the latter vessels. The middle coat is more thin and distensible than that of the arteries; the greater number of its fibres are longitudinal. The internal coat is a thin shining membrane, continuous with that which lines the auricles of the heart. In its passage along the veins (those of the extremities) it is thrown into folds at different intervals, which constitute valves, which are so arranged as to allow the blood to flow freely towards the heart, whilst they effectually prevent its re-gurgitation backwards, into the parts from which it had been conveyed. The valves are of a lunated form, the convex border being continuous with the membrane lining the interior of the vessel, the straight or free one projecting towards its centre, where it comes into contact with a similar fold, extending from the opposite side, so that both form a complete septum across the interior of the vessel. The valves may be likened to so many minute flood-gates, all inclined in the direction towards which the stream flows, marking thereby its natural course, and constructed so as to prevent its return, at the same time that, by supporting the column of blood which intervenes between them and the heart, and preventing it from gravitating on that which follows, they remove a considerable impediment to its progress along the veins. This, it will be observed, is merely a mechanical advantage; but the venous system, considered as a whole, seems to have been constructed on a general hydraulic principle, which materially influences the passage of the blood it contains. It presents, on a general view, a series of cylindrical tubes, commencing in the interior of the

different organs of the body, as well as in their remote or peripheral extremities. These, in the first instance, are so minute as to elude vision, but they gradually increase in size and diminish in number, forming successively vessels larger and larger, until finally all terminate in a large trunk. Though the calibre of any given vessel in the series is larger than that of either of the branches which open into it, yet its diameter is less than the sum of their diameters taken together, whence it follows, by a necessary consequence, that the diameter of the common trunk is less than the sum of the diameters of the smaller vessels, whose contents it receives. Now, when a current flows from a wider into a narrower bed (its level remaining unaltered) it necessarily becomes more rapid as it advances; and by an extension of the same principle, when a number of tributary streams open into a channel whose width is less than that of their currents taken together, a certain impetus is given by the mere fact of such an arrangement, which materially aids any other collateral means that may have been devised for expediting its progress.

When describing the veins, it is not by any means necessary to enter into such details as are required when treating of arteries. They for the most part follow the course of the arteries, and therefore maintain the same relation to contiguous parts. We shall therefore briefly state their distribution and arrangement.

289. The veins of the lower extremity, as in other parts of the body, are divisible into two sets, of which one is deeply seated, whilst the other runs superficially between the common integument and fascia. The deep veins, following the course of the arteries and their ramifications, assume the names of the vessels they accompany; the superficial veins, with one or two exceptions, have no corresponding arteries. The deep veins commence in the foot, by branches which follow the course and arrangement of the dorsal and plantar arteries. As they emerge from thence, they become gradually larger, and apply themselves

to the anterior and posterior tibial arteries. In the leg we usually find two veins, one on each side of the artery, from which circumstance they are named *venæ comites, venæ satellites.* The anterior and posterior tibial veins (the latter having previously received the peroneal) unite near the lower border of the popliteus muscle, and form by their junction the popliteal vein.

290. The *popliteal vein,* thus formed, receives branches corresponding with the articular vessels; but its chief branch is the external saphena vein. This vessel (*vena saphena exterior vel minor*) commences by several irregular branches on the dorsum of the foot. These unite into a trunk, which turns round the outer ankle, and gradually inclines backwards to the tendo Achillis. Passing along the border of the tendon, it gets on the belly of the gastrocnemius muscle, on which it ascends, accompanied by the external saphenous nerve, with which it runs between the heads of the gastrocnemius, and pours its contents into the popliteal vein. In its course through the ham, the popliteal vein is placed posterior and exterior to the artery, that is to say, between it and the nerve. Thus situated, it passes up through the aperture in the adductor magnus, and becomes continuous with the femoral vein.

291. The *femoral vein* extends, like the artery which it accompanies, through the upper two-thirds of the thigh. Placed at first behind that vessel, it gradually inclines inwards and forwards, so that on reaching Poupart's ligament (where it terminates in the iliac vein) it lies on the inner side, and on the same plane as the artery, being separated from it only by a slight lamella that passes from before backwards, across the membranous tube which invests them. In the lower part of its course, the vein receives all the venous branches that accompany the ramifications of the arteries. In the upper part, the profunda vein opens into it, which returns the blood from all that part of the muscular structure of the thigh supplied by the profunda artery; it

also receives a large superficial vein, viz. the saphena major.

292. The *internal saphena vein* (*vena saphena major vel interna*) runs along the inner side of the limb from the inner ankle, to within an inch and a half of Poupart's ligament. In this course it lies quite superficial between the skin and fascia. It commences by some irregular branches, which form a sort of plexus on the inner side, and on the dorsum of the foot. From these a straight branch arises and passes upwards in front of the inner malleolus, and thence along the corresponding border of the tibia, accompanied by the internal saphenous nerve. At the knee, the vein inclines a little backwards, as it passes by the internal condyle, after which it ascends along the inner and anterior side of the thigh, and terminates in the femoral vein, after passing through an aperture in the fascia lata, which from this circumstance has been termed the saphenic opening. To the same point some other superficial veins converge, viz. the *superficial epigastric* and *pudic*, the former passing down from the abdomen, between the lamellæ of the superficial fascia, the latter from the groin and pubes; both open into the saphena major near its termination.

The femoral vein, placed at the inner side of the artery, enters the abdomen through the crural ring, and assumes the name of *external iliac vein*. This vessel, lying at first on the inner side, and on the same plane with the artery of the same name, gradually inclines somewhat behind it, as it approaches the sacro-iliac symphysis, where it joins the internal iliac vein, to form with it the common iliac vein. Near its commencement at Poupart's ligament, the external iliac receives the circumflexa ilei and epigastric veins.

293. The *internal iliac*, or *hypogastric vein*, returns the blood from all the parts within the pelvis, and on its exterior, that are supplied by the branches of the artery of the same name. These unite and form a short trunk, which joins the external iliac vein, as has been above stated.

294. The *common iliac vein* (*vena iliaca primitiva vel communis*) formed by the confluence of the two iliac veins, passes upwards, converging towards the corresponding vessel of the opposite side, and both unite at the junction of the fourth with the fifth lumbar vertebra, a little to the right of the middle line, where they terminate in the inferior or ascending cava. The right is shorter, and nearly vertical in its direction, and both pass under the right common iliac artery.

The Absorbent, or Lymphatic Vessels of the Lower Extremity.

295. The absorbent system, considered as a whole, is made up, 1, of vessels which convey into the general circulation lymph or chyle, and which from this circumstance are divided into two orders, viz. lymphatics and lacteals. The latter are confined to the cavity of the abdomen, and only absorb chyle, the product of digestion; the former are diffused through the body at large, and are engaged in that process of absorption which is constantly going on in the different structures of which it is composed. 2. In different parts of the course of the absorbing vessels, rounded or oval bodies are situated, called *glands* (*lymphatic* or *conglobate*) which in the extremities are found usually in the flexures of joints, but in the cavities are variously disposed. The vessels, as is evident from the results of injection, on arriving at the glands, become intimately connected with them, and in a manner ramify through their interior; for if some quicksilver be introduced into the vessel, it will soon permeate the whole substance of the gland. The entering vessels are on this account called *vasa inferentia*. The vessels which issue from the glands appear to arise from their interior by a number of minute radicles, which unite to form tubes of about the same size as those which had entered at the opposite side. These pass on in the course of the circulation, and as they convey away whatever fluids had passed through the glands, they are called *vasa effe-*

rentia. It should be observed, that anatomists are by no means agreed as to the precise distribution of the minute tubuli, which are convoluted in the interior of the glands. All the chyliferous vessels, as well as all the lymphatics that arise from the lower extremities, from the left side of the thorax, the left upper extremity, and the lateral half of the head and neck of the same side, pour their contents into a common trunk—the *left,* or *great thoracic duct* (*ductus thoracicus sinister vel major,* Soemm.). This is a tube similar in structure, but larger than those which open into it, extending from the second lumbar vertebra to the lower part of the neck, where it opens into the angle formed by the union of the left subclavian and jugular veins. The rest of the lymphatics, consisting of those which return the lymph from the left upper extremity, from the left half of the thorax, and the corresponding side of the head and neck, terminate in a short trunk, the *right,* or *small lymphatic duct,* which opens into the junction of the right subclavian and jugular veins.

296. The vessels of this order consist of two coats, of which the external one, dense and firm, is composed of cellular tissue, whilst the internal one is thin, smooth, and delicate, not unlike that of the veins. This membrane is also formed into folds along their course, which constitute valves that allow the contained fluid to pass freely on towards the common trunk, but effectually prevent its return.

297. The lymphatic vessels of the lower extremity, as well as in other parts of the body, are divisible into two sets, of which one is superficial, and accompanies the saphena vein, the other deep-seated, follows the course of the deep vessels. The superficial lymphatics are placed between the fascia and common integument, and can be traced from the dorsum of the foot, beginning at the digital phalanges. In this situation the minute branches ramify, forming an interlacement, from which ten or twelve vessels proceed, converging towards the fore-part of the inner

ankle, where they come into contact with the saphena vein. Along this vessel, which may be said to guide or conduct them in their course, the lymphatics ascend towards the inside of the knee. In their passage they communicate with similar vessels (but fewer in number) which run along the external and posterior sides of the limb, and finally terminate near the knee in those which accompany the saphena vein. Still following the course of the vessel just referred to, and maintaining constant communications on each side, the superficial lymphatics ascend along the inner and anterior part of the thigh, and, beneath Poupart's ligament, pass into the superficial inguinal glands, from which several vasa efferentia proceed, and after dipping down through the saphenic opening in the fascia lata, join the deep-seated lymphatic vessels, which accompany the femoral and iliac vessels upwards into the abdomen. The superficial inguinal glands receive the lymphatics which descend from the forepart of the abdomen, together with the superficial epigastric vessels, as well as those which accompany the external pudic branches, and transmit them onwards to the same destination as those whose course we have above indicated.

298. The *deep-seated lymphatic* vessels lie under cover of the fascia lata, embedded amongst the muscles. They accompany the femoral vessels and their various ramifications, and may be said to arise from the parts to which these vessels are distributed. One or two branches twine round the anterior tibial artery, and with it pass through the opening in the inter-osseous ligament; another set commences in the sole of the foot, and follows the posterior tibial artery up to the ham, where they receive the anterior vessels; a third proceeds to the same point, guided by the peroneal artery, and all three open into the popliteal glands. A fourth set, commencing on the external side of the dorsum of the foot, runs behind the outer ankle, where they meet the external saphena vein, with which they ascend upon the muscles of the calf of the leg, to terminate in the

deep lymphatics, or in the popliteal glands. From these glands three or four trunks issue, which, after passing through the opening in the adductor magnus muscle, receive all the minor ramifications in their course through the thigh, and end in the deep inguinal glands. The vasa efferentia from these glands pass up into the abdomen, along with the iliac vessels, but in order to come into contact with them, they must necessarily pierce the funnel-shaped prolongation sent down to invest them by the fascia iliaca and transversalis. After piercing the inner side of this membranous tube (which by their numerous perforations they render cribriform) they pass through a large lymphatic gland, situated in the crural ring, after which they twine round the iliac vessels, dividing into offsets, and uniting again, so as to form a sort of net-work. Finally, the lymphatics here described converge towards those of the opposite side, at the bifurcation of the aorta, and the commencement of the inferior cava, round which they form a plexus similar to that on the iliac vessels, and on reaching the second, or third lumbar vertebra, they terminate in one of the trunks that open into the receptaculum chyli, or commencement of the thoracic duct.

All the vessels which we have described as ramifying on the exterior of the pelvis, viz. the gluteal, sciatic, obturator, &c. are accompanied by lymphatics, which follow their course, and unite to form a plexus round the internal iliac vessels, which however finally opens into the larger lymphatic trunk that ascends from the lower extremity, accompanying the femoral and iliac vessels.

SECTION IV.

THE NERVES OF THE LOWER EXTREMITY.

299. The nerves intended to communicate the power of sensation and motion to the lower extremity, are derived from the lumbar and sacral plexus, that is, from a net-work,

or interlacement, which the anterior branches of the lumbar and sacral nerves form, after they have passed out of the spinal canal. The lumbar nerves, five in number, arise by double roots from the medulla spinalis. The trunks, formed by the union of each pair of roots, pass through the intervertebral foramina, the first being transmitted through that between the first lumbar vertebra and the second, the fifth through that between the last and the sacrum. These trunks are very short, being not more than a few lines in length, as they immediately divide into two branches, called from their direction anterior and posterior.

300. 1. The *posterior* branches of the lumbar nerves pass backwards, immediately after their division, between the transverse processes of the vertebræ, and are distributed to the deep-seated extensor muscles, situated along the spine, some of their branches extending as far as the skin. The course and destination of these nerves being similar in every respect, it is not necessary to describe them separately, more especially as anatomists have not designated them by particular names, doubtless from the circumstance of their not being connected with any points of practical importance. It may be just observed, that they diminish gradually in size from the first to the last.

301. 2. The *anterior* branches of the lumbar nerves incline outwards as they descend, and become mutually connected by communicating filaments, sent from one to the other. In this way a plexus, or interlacement, is formed, reaching from the second to the fourth lumbar vertebra, resting on the junction of the transverse processes with their bodies, and covered by the psoas muscle. In addition to this mutual communication, each nerve receives one or two small filaments from the lumbar ganglia of the sympathetic nerve. The plexus is moreover brought into relation with the dorsal nerves by a branch sent up from the first lumbar to the last dorsal, and also with the sacral nerves, by one sent down from the fifth. As the latter

communicating branch, which is of considerable size, has been named *lumbo-sacral*, the former, though very small and delicate, may with equal propriety be termed *lumbo-dorsal*. The lumbar plexus thus constituted, gives off the following branches, which if taken in the order of their origin, from above downwards, may be thus arranged: the musculo-cutaneous, external cutaneous, external pudic, the crural and obturator nerves, and lastly, the lumbo-sacral, or communicating branch.

302. 1. The *musculo-cutaneous* branches are usually two in number, and are derived either from the first lumbar nerve, or in some cases from the filament sent from it to the second. Both pass downwards and outwards from under the psoas muscle, supported on the quadratus lumborum, to the posterior part of the crista ilei. While in the lumbar region, these branches run parallel, one being placed a little superior and external to the other. *a*. The *external* branch (*ileo-scrotal*, or *ileo-inguinal*) on reaching the posterior part of the crista ilei, gets between the transversalis and internal oblique muscles, and divides into two ramusculi, one of which, after giving some twigs to the transversalis and iliacus, pierces the abdominal muscles, becomes subcutaneous on the posterior part of the ileum, and is distributed to the skin over the gluteus medius and maximus. The other proceeds obliquely forwards and inwards, as far as the anterior superior spine of the ileum, and then takes the direction of the crural arch. On reaching the abdominal ring, it passes outwards, together with the spermatic cord, to which it distributes several filaments; some also reach the skin of the scrotum, others that on the pubes and labia in females. The distribution of the branches of this nerve indicates the propriety of the names applied to it, viz. ileo-scrotal, or ileo-inguinal. *b*. The second, or more *internal* branch, after descending a little, lies on the fascia iliaca, covered by the peritonæum. After runn[illegible] for a while parallel, and within half an inch of the c[illegible] pa[illegible] ie

fibres of the transversalis, and so is placed between that muscle and the internal oblique, and soon after between the latter and the external oblique. To these muscles it gives delicate branches, and terminates by sending two or three which ramify on the integument of the groin and scrotum, after having passed through the external abdominal ring.

303. 2. The *external cutaneous* branch (*inguino-cutanée*, Chauss.) passes from beneath the psoas muscle on a level with the crista ilei, runs from thence downwards, and a little outwards, lying on the fascia iliaca. On reaching the anterior superior spinous process of the ileum, it emerges from the pelvis, by passing through the interval between that process of bone and the inferior one, after which the nerve divides into two ramusculi, which separately pierce the fascia lata of the thigh, and proceed to different destinations. *a.* One of these inclines backwards, and becoming subcutaneous, runs over the tensor vaginæ muscle, and along the external part of the thigh, placed between the fascia and the integuments, distributing filaments as it descends, until it ceases to be discernible about the union of the middle with the lower third of the thigh. *b.* The *anterior* branch pierces the fascia from an inch and a half to two inches, below the anterior superior spine of the ileum, becoming also subcutaneous, and ramifies as far as the external side of the knee, in numerous delicate filaments, which will be found on the fascia covering the vastus externus muscle.

304. 3. The *external pudic* branch (*nervus spermaticus externus*, Soemm.; *genito-cruralis*) arises from the second lumbar nerve, pierces through the fibres of the psoas muscle and the fascia that covers it, and then runs vertically downwards, lying on the anterior surface of that muscle. In this course it is covered by the peritonæum, and on approaching the crural arch, it divides into two ramusculi, one being internal, the other external in its direction. *a.* The *internal* ramusculus, somewhat larger and longer than

deep lymphatics, or in the popliteal glands. From these glands three or four trunks issue, which, after passing through the opening in the adductor magnus muscle, receive all the minor ramifications in their course through the thigh, and end in the deep inguinal glands. The vasa efferentia from these glands pass up into the abdomen, along with the iliac vessels, but in order to come into contact with them, they must necessarily pierce the funnel-shaped prolongation sent down to invest them by the fascia iliaca and transversalis. After piercing the inner side of this membranous tube (which by their numerous perforations they render cribriform) they pass through a large lymphatic gland, situated in the crural ring, after which they twine round the iliac vessels, dividing into offsets, and uniting again, so as to form a sort of net-work. Finally, the lymphatics here described converge towards those of the opposite side, at the bifurcation of the aorta, and the commencement of the inferior cava, round which they form a plexus similar to that on the iliac vessels, and on reaching the second, or third lumbar vertebra, they terminate in one of the trunks that open into the receptaculum chyli, or commencement of the thoracic duct.

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301. 2. The *anterior* branches of the lumbar nerves incline outwards as they descend, and become mutually connected by communicating filaments, sent from one to the other. In this way a plexus, or interlacement, is formed, reaching from the second to the fourth lumbar vertebra, resting on the junction of the transverse processes with their bodies, and covered by the psoas muscle. In addition to this mutual communication, each nerve receives one or two small filaments from the lumbar ganglia of the sympathetic nerve. The plexus is moreover brought into relation with the dorsal nerves by a branch sent up from the first lumbar to the last dorsal, and also with the sacral nerves, by one sent down from the fifth. As the latter

communicating branch, which is of considerable size, has been named *lumbo-sacral*, the former, though very small and delicate, may with equal propriety be termed *lumbo-dorsal.* The lumbar plexus thus constituted, gives off the following branches, which if taken in the order of their origin, from above downwards, may be thus arranged: the musculo-cutaneous, external cutaneous, external pudic, the crural and obturator nerves, and lastly, the lumbo-sacral, or communicating branch.

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fibres of the transversalis, and so is placed between that muscle and the internal oblique, and soon after between the latter and the external oblique. To these muscles it gives delicate branches, and terminates by sending two or three which ramify on the integument of the groin and scrotum, after having passed through the external abdominal ring.

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304. 3. The *external pudic* branch (*nervus spermaticus externus*, Soemm.; *genito-cruralis*) arises from the second lumbar nerve, pierces through the fibres of the psoas muscle and the fascia that covers it, and then runs vertically downwards, lying on the anterior surface of that muscle. In this course it is covered by the peritonæum, and on approaching the crural arch, it divides into two ramusculi, one being internal, the other external in its direction. *a.* The *internal* ramusculus, somewhat larger and longer than

the other, turns forwards a little, so as to come into contact with the spermatic cord, or round ligament, which it accompanies through the abdominal ring, being distributed to the cremaster muscle and the investments of the testis in the male, some of its filaments extending also to the neighbouring parts of the groin, and in the female to the labia and pubes. *b.* The *external* branch inclines outwards in front of the external iliac vessels, just at their termination, passes beneath the crural arch, and divides into several filaments, which ramify in the inguinal region and front of the thigh, some of them becoming subcutaneous.

305. 4. The *crural nerve* (*nervus femoralis*, Soemm.; *femoro-pretibial*, Chauss.) arises from the second, third, and fourth lumbar nerves, the greater part being derived from the two last; in some instances also it receives a small filament from the first, or from the communicating branch that passes between it and the second. The nerve thus formed is of considerable size, and is situated at first deeply, in the sulcus between the contiguous margins of the psoas and iliacus muscles. As it descends it comes forwards somewhat, so as to become apparent, though it still remains covered by the fascia iliaca, and is guided to the crural arch by the psoas muscle (its external border) which separates it from the iliac artery. In this course the nerve gives from its external side several small filaments to the iliacus muscle; internally some also pass over the iliac vessels, and others to the psoas muscle. Amongst the latter, one may be observed to take a retrograde course, running from below upwards on the muscle. Close to Poupart's ligament, or immediately after it has passed beneath it, the anterior crural nerve spreads out and divides into a lash of branches which diverge to their different destinations, and may be divided into a superficial and deep set, the former piercing the fascia, and becoming subcutaneous, forming the cutaneous nerves of the anterior and inner parts of the thigh, the latter remaining covered by that membrane.

a. The *superficial* branches are usually two, sometimes there are more. They pierce the fascia from half an inch to an inch below Poupart's ligament, one just in front of the femoral artery, the other about midway between that point and the external border of the thigh. The former may be called the internal, the latter the middle cutaneous branch, inasmuch as it lies intermediate between it and the external cutaneous nerve (its anterior branch) already described. The middle cutaneous branch passes down beneath the integument, lying on that part of the fascia which covers the rectus muscle, and may be traced as far as the front of the knee. The internal ramusculus takes nearly the course of the great saphena vein, distributing filaments as it descends over the sartorius and vastus internus, as far as the inner side of the knee joint.

b. The *deep-seated* branches are very numerous, and admit of being divided into an external, internal, and long, or descending set, the two former being distributed altogether to the muscles, the last partly to muscles, partly sub-cutaneous. The long descending branches are two in number; they both incline inwards, as they descend, and come into contact with the sheath of the femoral vessels, where they are crossed by the sartorius muscle. One of these (*nervus saphenus minor*) lies along the external side of the sheath of the vessels for some way, and distributes filaments to the sartorius as it descends; it soon however inclines outwards, and ramifies in the vastus internus, as far as the knee. The other branch (*saphenus major vel internus; tibio-cutané*, Chauss.) is larger and much longer than the preceding. After running for some way upon the sheath of the vessels, it penetrates it so as to come into contact with the coats of the artery, and lies for about the middle third of the thigh on the superior and external side of that vessel. When the artery is about to pass backwards into the popliteal space, the nerve ceases to accompany it, and continues its course directly down to the knee, covered by the sartorius, to which it gives some filaments. Opposite the inner condyle, the saphenous nerve may be found between the tendons of the sartorius and gracilis muscles. In this situation the nerve becomes sub-cutaneous, and applies itself to the saphena vein, which it accompanies along the anterior and inner side of the leg, distributing filaments to the integuments, as it descends. It passes with the vein in front of the inner ankle, and ramifies by several minute filaments as far as the dorsum of the great toe.

The rest of the deep-seated branches are distributed exclusively to the muscles of the thigh, and may, as we have said, be divided (from a consideration of their direction,) into an external and an internal set. The *external* branches incline outwards in front of the iliacus and psoas muscles, gradually diverging as they proceed. They get under cover of the sartorius, and give off three or four filaments for its supply, some of which pierce the fibres of the muscle, and ramify on its anterior surface. Other branches, still very numerous, pass beneath the rectus and tensor vaginæ femoris, supplying both, the remainder being distributed to the psoas and iliacus muscles after their junction, and finally to the two vasti and the crureus. The *internal* set of branches, not so large or so numerous, incline inwards beneath the femoral vessels, and supply the pectineus and adductor longus.

306. 5. The *obturator nerve* (*nervus obturatorius*, Soemm.; *nerf sous-pubio-femoral*, Chauss.) arises from the third and fourth lumbar nerves, and is smaller than the crural nerve, from which it is separated by the breadth of the psoas muscle, one running along its external border in the iliac fossa, the other placed beneath its inner margin, along the brim of the pelvis. In this course the nerve lies between the peritonæum and the pelvic fascia, being situated about half an inch above the corresponding artery, (when it arises from the internal iliac,) but gradually de-

scends, so as to come into contact with it as they approach the thyroïd foramen, through which they pass out from the pelvis, and reach the upper part of the thigh. In this situation the nerve lies deeply between the pectineus and obturator externus muscles, and divides into two branches, one lying on a plane anterior to the other, the adductor brevis being in fact interposed between them.

a. The *anterior* branch descends under cover of the pectineus, and divides into two ramusculi, one of which is given to the adductor brevis, the other to the adductor longus and gracilis. *b.* The *posterior,* or deeper branch passes backwards as it descends between the adductor brevis and magnus, giving filaments to both, as well as to the obturator externus.

307. 6. The *communicating nerve* (*nerf lombo-sacré,* Bichat) is the last off-set from the lumbar plexus, and in size is larger than either of the preceding nerves. It is made up of the whole of the anterior branch of the fifth pair, and of the connecting branch sent down from the fourth. It passes backwards in front of the sacro-iliac symphysis to reach the pelvis, where it joins the first sacral nerve, and so contributes to form the sacral plexus, at the same time that it forms the connecting link between it and the lumbar plexus. Before its termination it gives off the gluteal branch (*nervus gluteus*), which is the only one that arises from it. It turns outwards beneath the border of the sciatic notch, and above the pyriformis muscle. On reaching the exterior of the pelvis, the nerve is covered by the gluteus maximus, to the substance of which it distributes branches, as well as to the other muscles of the same name, and so may be said to terminate.

308. The *sacral nerves,* five, and not unfrequently six in number, arise from the extremity of the medulla spinalis, which, it may be observed, ceases in the adult subject opposite the second lumbar vertebra. The fasciculi, which compose the roots of these nerves, must therefore descend

almost vertically in the sacral canal, to reach the foramina through which they are transmitted; and as they are divided into a number of filaments, proceeding from a root, or common point of attachment, they assume that peculiar appearance which has given rise to the term usually applied to them—*cauda equina*. While yet within the sacral canal, the two roots, by which each nerve arises, unite to form a common trunk, which soon divides into branches that take quite an opposite course, one being directed backwards, the other forwards.

309. The *posterior* branches of the four superior sacral nerves, like those of the lumbar set, are much smaller than the anterior; they pass backwards through the posterior sacral foramina, penetrate the tendinous origin of the sacro-lumbalis muscle, to which they distribute filaments in their passage, and become sub-cutaneous. Each of these branches inclines outwards lying on the fascia that covers the gluteus maximus muscle, and is finally distributed to the skin covering the nates. The posterior branches of the two last sacral nerves are much smaller than any of the others; they pass downwards and forwards to supply the integuments round the margin of the anus.

310. The *anterior* branches of the sacral nerves pass forwards through the anterior sacral foramina, and are placed deeply in the cavity of the pelvis, where they form a plexus, not as in other instances, by sending fasciculi from one to the other, so as to constitute an interlacement, but by an union of their fibres, forming a large compressed cord, from which nerves are given off. This plexus (*plexus sacralis vel ischiadicus*) is situated at the posterior and lateral part of the pelvis, resting on the surface of the pyriformis muscle, crossed by some of the branches of the internal iliac artery, and covered (particularly at the left side) by the rectum. It is formed by the union of the anterior branches of the four first sacral nerves, together with the communicating nerve sent down from the fourth and fifth lumbar

nerves. The two last sacral nerves do not enter into its formation. The branches of the sacral plexus may be divided into two sets, one internal, the other external: the former consisting of the hemorrhoidal, vesical, uterine, and pudic, are distributed to the parts in the pelvis and perinæum, and shall be described after we have examined the pelvic viscera; the latter being intended for the supply of the lower extremity, come within the limits of our present section: they are the small, or lesser, and the great sciatic nerves.

311. *a.* The *lesser sciatic* nerve *(petit femoro-poplité,* Chauss.; *branche fessière inferieure,* Bichat) arises from the posterior and lower part of the plexus, from which it inclines backwards and downwards to reach the lower border of the pyriformis muscle, beneath which it escapes from the pelvis. In this situation it will be found on the same plane with the great sciatic nerve, but on its inner side, both resting on the superior gemellus, and covered by the gluteus maximus. Here the nerve may be said to divide into branches which take different directions; one outwards to the glutei, others inwards, and a third set downwards along the thigh. It is however more conformable with usage to consider the descending part as the proper continuation of the nerve, and the others as its offsets or branches: *a,* the *inferior gluteal* branches may be so called to distinguish them from the proper gluteal nerve, which arises from the lumbo-sacral, or communicating branch, from which, at their exit from the pelvis, they are separated by the breadth of the pyriformis muscle. The greater number of these branches are very short, as they have merely to turn outwards a little, in order to reach the pelvic surface of the gluteus maximus, to which they are distributed. One of them however may be observed to curve round the border of the pyriformis, and proceed obliquely forwards beneath the gluteus, extending as far as its anterior border. *b.* A small branch, inclines inwards

beneath the tuber ischii, and divides into filaments, some of which are distributed to the gracilis, whilst others pierce the fascia, and become sub-cutaneous, ramifying in the integument that covers the upper and inner part of the thigh, and also of the perinæum. *c.* From the posterior surface of the nerve, when it is on a level with the lower border of the gluteus, a branch passes backwards through the fascia, and becomes sub-cutaneous. It continues to descend, distributing filaments to the skin, as far as the popliteal space, where it finally ceases. Now, the branch *b* may be named the posterior and superior cutaneous branch, and that marked *c*, the posterior and middle cutaneous, to distinguish them from another situated more externally, and derived from the great sciatic nerve; for these three branches lie on the fascia, and supply the integument on the posterior part of the thigh.

The continuation of the nerve, as it descends, inclines inwards, covered by the fascia, and resting on the flexor muscles, to which it distributes branches, in its course towards the inner side of the popliteal space, where it finally ceases.

312. The *great sciatic nerve* (*nervus ischiadicus*, Soemm.; *grand femoro-poplité*, Chauss.) is the largest nerve in the body. From its size and direction it may be considered as the continuation or prolongation of the plexus, it being impossible to determine where the one ceases, or the other begins. The fasciculi which enter into its composition are derived from the anterior branches of the four first sacral nerves, and of the fifth lumbar, as well as half the fourth. Thus formed, the nerve emerges from the pelvis, beneath the lower border of the pyriformis muscle, lying in the interval between the trochanter major and tuber ischii, whence it proceeds almost vertically downwards to the popliteal space. In the upper part of this course it rests against the external rotator muscles, in the rest it is supported by the adductor magnus, and is covered for a short way by

the gluteus, and lower down by the flexor muscles; but in the ham it is placed in the interval between them, embedded in a quantity of adipose substance, and covered only by the fascia and integument. The branches of this nerve are necessarily very numerous, but may be arranged as follows: *a*, from its posterior surface some filaments pass to the gluteus muscle, whose size and number depend on that of the inferior gluteal branches, derived from the lesser sciatic nerve, being few and small when the latter are numerous, and *vice versâ*. For here, as elsewhere, in the nervous, as well as in the vascular system, a principle of compensation obtains, by which, when the supply from one source is considerable, that from another admits of being proportionally diminished. Farther down it gives filaments to the flexor muscles, as they lie over it. From some of these branches, or from the trunk itself, one or two others pass backwards, and directly pierce the fascia, after which they proceed down towards the external side of the ham, ramifying in the integuments. These may be termed the posterior and external cutaneous branches, to distinguish them from those that arise from the lesser sciatic nerve. *b*. From its anterior surface several branches proceed to supply the external rotators and the adductor magnus, on which it lies: *c*, some pass outwards to the short head of the biceps.

313. About the middle of the thigh, the sciatic nerve divides into an external and internal branch, the latter, in direction and size, being its proper continuation. This division sometimes takes place lower down than the point here indicated, and in many instances much higher, for the two parts of the nerve, though in apposition in the middle of the limb, are often found separated superiorly by part of the pyriformis muscle, through which one of them passes. The internal, or larger division, lies behind, and to the outer side of the popliteal artery, whilst in the popliteal space; hence during that part of its extent it may be called the popliteal nerve. According to the arrangement usu-

ally adopted, the nerve is considered as dividing into two branches, viz. the posterior tibial and fibular. But were we to adhere to this division, we should have no popliteal nerve, and it would evidently be a misnomer to speak of the posterior tibial in the popliteal space, and describe its relations to the popliteal artery. When treating of the external division, we cannot avoid this otherwise than by a periphrasis.

314. The internal, or larger division of the sciatic nerve, (*popliteal*) passes directly downwards through the ham, covered by the fascia, and lying posterior and external to the popliteal vessels, from which it is separated by some adipose substance. After having passed below the joint, it rests on the popliteus muscle, covered by the gastrocnemius. In this situation it lies on the same plane as the artery, but to its external side. As it descends along the leg, it maintains the same relation to the artery, and, like it, assumes the name of *posterior tibial* when it has passed below the popliteus muscle. In the leg it lies on the tibialis posticus and flexor communis muscles, covered by the deep fascia which separates it from the soleus. It gradually inclines inwards as it descends, passes through that arched interval which separates the inner ankle from the calcaneum, and, like the artery which it accompanies, divides into its two terminal branches, viz. the internal and external plantar.

315. In this course the nerve gives several branches to supply the parts along which it passes. *a.* A branch of considerable size (*nervus cutaneus longus posterior, vel communicans tibiæ*, Soemm.) runs directly downwards between the heads of the gastrocnemius, and then over the posterior surface of that muscle, gradually inclining outwards to reach the external border of the tendo Achillis. In this course the nerve accompanies the external saphena vein; and about the middle of the calf of the leg, or sometimes lower down, it joins with a corresponding branch sent from the fibular nerve. The nerve resulting from this union

passes down with the vein behind the external ankle, so as to reach the dorsum of the foot, where it divides into two branches, one running on the fourth, the other on the fifth metatarsal bone, and distributing filaments as far as the corresponding digital phalanges. The branch here described lies beneath the fascia in its course down the leg, but at different intervals sends through it filaments which ramify in the integuments, some of them descending as far as the interval between the ankles. *b.* Several muscular branches proceed from the nerve to the heads of the gastrocnemius, the plantaris, popliteus, and soleus muscles; and in the lower part of its course it supplies also the tibialis posticus, and the long flexors, its filaments diverging and uniting again so as in some places to form a mesh round the posterior tibial artery.

316. When arrived at the hollow of the calcaneum, and lying under cover of the abductor pollicis muscle, the posterior tibial nerve divides into the internal and external plantar branches. 1. The *internal* plantar branch, the larger of the two, passes directly forwards beneath the tarsal bones, concealed by the abductor pollicis muscle, to which, as well as to the flexor accessorius, and flexor brevis, it gives branches. It soon divides into, or gives off four branches, intended to supply both sides of the great toe, and of the two next to it, as well as the inner side of the fourth. *a.* The first ramusculus is smaller than any of the others; it proceeds forwards and inwards beneath the flexor brevis pollicis, to reach the inner side of the great toe, forming its first collateral branch: *b,* the *second,* as it passes forwards, corresponds with the interval between the first and second metatarsal bones, where it gives filaments to the flexor brevis and the first lumbricalis, and on reaching the fissure between the toes, divides into two off-sets, which run along the contiguous borders of the first and second toes: *c,* the *third,* lies in the second metatarsal space, supplies the first plantar interosseous muscle, and, like the

preceding branch, divides into two parts to supply the external border of the second toe, and the adjacent one of the third; *d*, the fourth ramusculus follows a similar course and distribution with regard to the third metatarsal space, and the digital phalanges of the third and fourth toes; it also joins with, or receives a filament from the superficial branch of the external plantar nerve.

2. The *external plantar* nerve proceeds forwards and outwards, lying between the flexor accessorius and flexor brevis digitorum. In this course it gives a branch which passes to the external border of the foot, and is distributed to the abductor minimi digiti, after which it divides into two branches, one being intended to complete the digital branches of the toes, the other to supply the deep-seated muscles in the sole of the foot. *a*. The *first* of these, on reaching the extremity of the fifth metatarsal bone, sends along the outer border of the foot, and of the little toe, a collateral branch, similar to that which is given to the great toe by the internal plantar nerve. The continuation of the branch may be observed to correspond with the fourth metatarsal space, where it communicates by an oblique filament with the internal plantar nerve; after which it proceeds to the heads of the metatarsal bones, and divides into branches, which supply the external border of the fourth toe, and the adjacent one of the fifth; *b*, the deep branch sends outwards a filament to the flexor of the little toe, and then proceeds almost directly forwards into the sole of the foot, where it divides into branches, which supply the abductor pollicis, the interossei, and transversus pedis muscles.

317. The external division of the great sciatic nerve (*nervus peroneus*, Soemm.; *branche peronière du grand fémoro-poplité*, Chauss.) inclines outwards as it descends from the point of division towards the external condyle of the femur, to which it is guided by the border of the biceps muscle. It then proceeds obliquely forwards, lying

in the interval between the external head of the gastrocnemius and the biceps, and reaches the posterior surface of the head of the fibula, where it may with propriety be named, *fibular* or *peroneal.* The nerve continues to descend for a short way, between the external surface of the bone and the peroneus longus muscle, where it is usually said to divide into two branches, one being named anterior tibial, the other the musculo-cutaneous. But as the latter, in size and direction, represents the continuation of the nerve, we shall so consider it, and treat the former as a branch, more especially as from its relations and course it is analogous to the interosseous branch in the fore-arm. As it passes downwards, the peroneal nerve lies between the peroneus longus and the extensor communis, and afterwards between the latter muscle and the peroneus brevis, giving branches to each. Towards the middle of the leg, it escapes from under cover of the muscles, much diminished in size, descends for some way beneath the fascia, and divides into two branches, one being a little external to the other. The *external* branch, lying between the fascia, covering the extensor tendons, and the skin, passes over the bend of the ankle and dorsum of the foot, and divides into three ramusculi on reaching the latter situation. One of these is directed forwards, corresponding with the fourth metatarsal space, and ramifies in filaments on the dorsum of the little toe, and outer border of the foot. In the latter situation its place is not unfrequently supplied by the external saphenous nerve. The next ramusculus passes along the interval between the fourth and third toes, supplying both; whilst the third, or most internal of them, is similarly disposed of on the phalanges of the third and second toes. The *internal* branch is directed towards the base of the first metatarsal bone, on which, after having given some filaments to supply the inner border of the foot, it divides into two ramusculi, which ramify on the upper surface of the first and second toes.

318. The branches of this nerve, taken in their order from above downwards, are as follows. *a.* A considerable branch is given off in the popliteal space, which descends between the external head of the gastrocnemius and the fascia, sending at intervals some branches which pierce the latter to supply the integuments. It finally divides into two or three branches, some of which ramify on the external side of the leg, whilst one joins with the superficial branch of the posterior tibial nerve, to form with it the communication alluded to in the description of the latter; *b*, the anterior tibial, or interosseous nerve, immediately after its origin below the head of the fibula, turns forwards and inwards between the surface of that bone and the peroneus longus and extensor communis, giving branches to both. On reaching the interosseous ligament, it lies to the external side of the anterior tibial artery, but as it descends it inclines somewhat in front of that vessel, and so passes beneath the annular ligament of the ankle joint to gain the dorsum of the foot. In this course the nerve gives off filaments to the muscles between which it lies, viz., the extensor proprius pollicis, and tibialis anticus, and finally terminates in the situation just referred to by dividing into two ramusculi, of which one passes forwards and supplies the extensor digitorum brevis, and some of the interossei, some of its filaments uniting with the terminal branches of the peroneal nerve. The other division proceeds inwards over the first metatarsal bone, and ramifies on the first and second toes. *c.* Several muscular branches are given by the peroneal nerve in the upper part of the leg, to the peronei and extensor muscles; and, finally, *d*, some small cutaneous branches which pass down towards the external ankle.

Dissection of the Nerves.—When commencing the dissection of the nerves of the lower extremity, it should be recollected that they consist of two sets, one lying between the skin and fascia, and distributed altogether to the integuments, the other more deeply seated, being covered by the fascia, and intended to supply the muscles. It becomes then necessary to examine these separately, taking the superficial nerves first; for if the fascia be cut through, so as to expose the others, the distinction between them is destroyed, and the subsequent steps of the process rendered confused and intricate. A difficulty, however, here presents itself. The superficial nerves being merely branches of the deep ones, it will not be easy to detect them at the different points at which they pierce the fascia, and so we are deprived of the advantage of prosecuting their dissection by proceeding from the trunk to the branches. All this can be got over by care and attention, more especially as the fascia supports the nerves, so that if they be once found, there can be no difficulty in following them throughout their entire course. The first incision through the skin may be made from the pubes to the crest of the ileum, parallel with Poupart's ligament, and about half an inch above it. From the centre of this, let another be drawn down to the inner condyle, through the whole length of the thigh, and there met by a transverse incision extending across the knee-joint. It may also be found convenient to subdivide the intervening space by another incision made in the same direction. The perpendicular incision should barely divide the skin and cellular tissue beneath it, the transverse ones should not sink into the latter, else they will cut across some of the superficial nerves, or possibly the saphena vein. In reflecting the flaps thus formed, the skin should be drawn forwards, and held as tight as possible, by which means, whilst the cellular membrane is being cautiously dissected, or rather scraped through, the nerves will be detected as they pierce the fascia at different intervals. If once discovered, the skin should be a little relaxed, and the nerve laid down on the fascia, after which, by holding the blade of the scalpel in the horizontal position, it can be readily made to pass along the cutaneous surface of the nerve from above downwards, all its lateral filaments being left untouched as they branch out on the fascia.

We have described three principal subcutaneous nerves on the anterior surface of the thigh. One of these usually pierces the fascia towards the external border of the limb, an inch and half below the spinous process of the ileum; another midway between that point and the pubis, and the third about midway between both. The internal one, it will be recollected, takes the direction of the saphena vein. The points here stated must of course be considered only as approximations to the fact, for superficial nerves, like branches of arteries, must be subject to many varieties in their course and distribution. But if the nerves be found, by searching for them in these situations, they can be readily traced by following the directions above given.

The *superficial nerves of the leg* may be exposed by making an incision through the skin from midway between the head of the fibula, and spine of the tibia, to the middle of the ankle. This should be bounded below by a transverse incision, extending from one ankle to the other; the upper end being afterwards prolonged to the border of the incision made during the dissection of the thigh. It will be found convenient to make another transverse incision across the middle of the leg, taking care that it does not go so deep as the fascia, else it will divide the saphena vein and the nerves. The internal flap of the skin may in the next place be cautiously raised over the inner condyle, and when the tendons of the gracilis and sartorius muscles are brought into view, the saphenous nerve will be found between them. There can then be no difficulty in tracing it in its entire extent from above downwards, particularly if it be drawn tight.

To expose the nerves on the dorsum of the foot, an incision may be made through the integument, from midway between the ankles to the middle toe. A lateral incision must also be made from each ankle to the corresponding border of the foot. The flaps of skin being cautiously reflected, will expose the terminations of the internal cutaneous nerve on the one side, and of the peroneal and external cutaneous on the other. If the fascia be in the next place divided close to the tendon of the extensor pollicis, the anterior tibial nerve will be readily found, and its branches traced forwards from that point along the foot. Finally, if that membrane be divided from the ankle to the knee, in the direction of our first incision through the skin, and the extensor pollicis and tibialis anticus separated and held apart, the anterior tibial nerve may be exposed in its entire course.

The *posterior set of superficial nerves* are derived from different sources. To trace them it becomes necessary to turn the subject prone, and support the abdomen by a high block. It will be recollected, from the description already given, that the superficial nerves of the pelvic region are derived superiorly from the muculo-cutaneous nerves of the lumbar plexus (their perforating or posterior branches), internally from the posterior branches of the sacral nerves, and externally from the external cutaneous nerve. In the middle of the thigh the superficial branches are furnished by the two sciatic nerves, and those of the leg from the peroneal and posterior tibial. To expose these, an incision may be made from about the middle of the fold of the nates, to midway between the condyles of the femur, which is to be bounded above and below by two transverse incisions extending across the limb. If the flaps of integument be carefully reflected, two or three large branches of nerves will be found piercing the fascia a little below the lower border of the gluteus muscle, which can from thence be easily traced down to the popliteal space, the fascia affording a guide to their dissection. As the process of this membrane which covers the gluteus maximus is very thin, and often indistinct, it is not easy to trace the superficial nerves upon it. We may commence by making an incision through the integument, along the whole length of the sacrum, and within an inch of its spinous processes. From the superior termination of this, another may be drawn transversely outwards, about two inches above the crista of the ileum, and parallel with it. Now if the skin be carefully dissected from the aponeurosis of the lumbar muscles, the posterior sacral branches will be found piercing it, and turning outwards over the gluteus. And again, if the same course be adopted along the transverse incision, the branches from the lumbar nerves will be observed, after passing through the abdominal muscles, close to the crista of the ileum, and proceeding down on the dense fascia covering the gluteus medius, and over part of the gluteus maximus. The posterior branch of the external cutaneous nerve will be found along the aponeurosis of the gluteus, after having penetrated the fascia some way below the anterior superior spine of the ileum. The branches which ramify on the posterior surface of the leg may be exposed by making a straight incision from the middle of the ham to the heel. This should be done with caution, as the fascia covering the muscles and the calf of the leg is very thin. The part of the membrane which is stretched across the popliteal space, and is dense and firm in its texture, will form a guide to the remainder, the dissection being proceeded with from above downwards.

The directions here given for the dissection of the superficial branches of the nerves may seem unnecessarily minute and prolix; and so they would be in reality, if they were calculated for no other purpose. They, however, include all that need be said relative to the first stages of the dissection of the lower extremity. For, whether the student directs his attention at the moment to nerves, or confines it to muscles or arteries, the lines of incision pointed out will answer equally well for either purpose; and when the same measures suffice for all, they simplify the process by their uniformity. The dissection prosecuted so far as to remove the integument from the entire of the limb, fully exposes the fascia, and enables us to view it as a whole, and to give a connected and detailed description of it. This we shall do, after making a few remarks on the dissection of the deep-seated nerves.

The subject still lying prone, the fascia may be divided in its entire extent by a perpendicular incision, corresponding with that made through the skin. The membrane may, in the next place, be carefully dissected off the flexor muscles, which, if drawn aside, will leave the sciatic nerve exposed. There can then be no difficulty in tracing it down into the popliteal space, or of following its various muscular branches, as they pass away on either side, provided the nerve be drawn tight, which will render their direction quite evident. But as the nerve, at its exit from the pelvis, is covered by the gluteus maximus, it becomes necessary to detach that muscle from its connexion with the great sciatic ligament and the side of the sacrum, and to draw it outwards. Whilst this is being done, branches of the nerve will be observed to enter its pelvic surface at different points. This proceeding exposes at the same time the lesser sciatic nerve.

To expose the peroneal nerve it will be found necessary to detach the peroneus longus and the extensor communis from the fibula, after which, if it be drawn tightly upwards, it will not be difficult to follow it and its branches in their entire extent.

If the cavity of the abdomen be opened, and the viscera removed, the anterior crural nerve will be observed close by the border of the psoas muscle, and the other branches of the lumbar plexus lying in the iliac fossa. If the muscle just named be turned inwards, and cautiously detached by proceeding from below upwards, the branches forming the plexus will be found beneath it. The general principle may then be acted on of proceeding from trunk to branch, and so the nerves thus exposed may be traced throughout their course. But, if the abdomen be not opened, we may proceed to dissect the nerves on the fore-part of the thigh in the following way: draw the edge of the scalpel lightly along the external border of the sartorius from its origin to where it crosses the adductor longus. Dissect the fascia off the muscle in the course of its fibres. Proceed in the same way with regard to the adductor longus. By this means a triangular space will be marked out, of which these muscles form the sides, and Poupart's ligament the base, and in the area of which lie the femoral vessels and the crural nerve. Through the centre and apex of this space runs the femoral artery, the vein being close on its inner side, the nerve about a finger's breadth to the outside. The fascia may be removed by making an incision through it, where it is attached to Poupart's ligament, and reflecting it inwards. The branches of the nerves will now be observed proceeding for the most part downwards and outwards. But their dissection must be conducted slowly, as they are embedded in a quantity of cellular tissue, and blended with the numerous arterial and venous ramifications found in this situation. It may be found useful to divide the sartorius in the middle, and to reflect it, and probably also to cut across the rectus at its origin, and draw it outwards. As the obturator nerve, at its exit from the pelvis, is concealed by the pectineus, it becomes necessary to cut through the origin of that muscle, and reflect it outwards, before the nerve can be seen; after which, in order to trace its branches, the adductor brevis must be divided and reflected in the same way.

SECTION V.

THE MEMBRANES OF THE LOWER EXTREMITY, AND OF THE ABDOMINAL PARIETES.

319. In the preceding section we have detailed the different methods to be adopted, and the successive steps to be pursued in commencing and proceeding with the dissection of the lower extremity. When by these means the common integument has been dissected off and removed, the limb will still be found invested by another membrane of quite a different structure, being of a glistening white colour, close in its texture, and composed of fibres crossing in various directions. Anatomists have classed it amongst the fibrous membranes, and named it the fascia lata of the thigh. The leg is enclosed in a similar investment, and so is the foot. But each presents certain peculiarities, which require a separate consideration.

320. The *fascia lata* of the thigh may be considered as its special or immediate investment, not only enclosing it in its entire extent from the knee to the pelvis and Poupart's ligament, but also sending processes inwards in several situations, which form septa between the muscles. The thickness of this membrane varies in different parts. It is considerable along the external side of the thigh, it is less so on its internal and posterior aspect; but anteriorly, it is in some places so thin as to require great care in dissecting off the skin, else the fascia will be removed with it. When examined towards the lower part of the thigh, it is found to be prolonged over the knee-joint, and to be continuous with a similar membranous investment of the leg. It has at the same time a connexion more or less intimate with all the bony prominences round the articulation, viz. with the two condyles on each side, with the tuberosities of the tibia below, with the head of the fibula to the outer side, to which it is guided by the biceps muscle, and finally, after

being stretched across the popliteal space, it is prolonged over the gastrocnemius muscle, and so becomes blended with the fascia of the leg.

321. When traced upwards, over the thigh, it is found not only to encase it, but also to send processes inwards between the muscles. The most dense and remarkable of these is one which passes in between the vastus externus and the short head of the biceps, and is attached to the linea aspera in its whole length as far as the insertion of the gluteus maximus. Along the internal side of the thigh it invests the muscles, and merely gives attachment to some thin cellular lamellæ, which lie between them; but along the course of the sartorius, particularly in the lower two-thirds of its extent, an investment or sheath is formed, which serves to maintain it in its place, notwithstanding the obliquity of its direction. Its points of attachment at the superior part of the limb are so numerous, that it becomes necessary to examine each of them in detail, more especially as one portion of the membrane bears an important relation to the parts connected with hernia. Thus externally, after having been intimately connected with the insertion of the gluteus maximus, it is prolonged backwards and upwards on the cutaneous surface of that muscle, and though very thin and weak, it still with care may be traced as far as to the side of the sacrum and coccyx, and also to the crista of the ileum, to which it is firmly attached, after having passed over the upper part of the gluteus medius. The fascia in the latter situation becomes very dense and firm, and is intimately connected with the fibres of that muscle. Still more externally it divides into two lamellæ, which embrace the inferior termination of the tensor vaginæ femoris, to which it in this manner gives insertion. These two lamellæ become united into one, along the posterior border of the muscle, which, by being prolonged over the gluteus medius (to whose fibres it gives attachment by its inner surface) passes to be inserted into the crista of the ileum and its spinous process.

Along the inner side of the thigh the fascia may be traced upwards over the adductor muscles, and becomes attached to the tuberosity of the ischium, and its ramus, as well as that of the os pubis, as far as its spinous process. The most important part of the membrane—that which has claimed the greatest share of attention from anatomists and surgeons, remains now to be considered, namely, the part immediately below Poupart's ligament, and which extends from the spinous process of the ileum to that of the pubis.

322. It will be recollected that the membrane forms an uninterrupted sheath, until it comes within a little more than an inch of Poupart's ligament. There a division takes place, and an opening is established for the transmission of the superficial vessels. The saphena vein, in its whole course, from the inner ankle to the knee, and from thence to the top of the thigh, lies superficial to the fascia. The superficial lymphatic vessels are similarly situated; the superficial epigastric vein and artery also descend over the abdominal muscles; and as all these vessels converge to one point, in order to pour their contents into the deep seated vein, an opening must be established for them in the fascia lata. The existence of this opening has caused a division of the anterior portion of the fascia into two parts, one external, the other internal. The external, or iliac portion passes upwards, lying on a plane, anterior to the vessels, and becomes blended with the lower border of Poupart's ligament, with which it continues to be thus united as far as the spinous process of the pubis. Whilst it is being prolonged in front of the femoral vessels, this part of the membrane, by reason of its inclination from below, upwards and inwards, must necessarily present a curved or falciform appearance, one extremity of it being at the lower border of the saphenous opening, the other at the spinous process of the pubis. Now, as the membrane stretches between these two points, its border becomes folded on itself, not ceasing abruptly at the margin of the opening, as at first sight may appear. On the contrary, it

is reflected on itself, and in the greater part of its extent passes outwards on the sheath of the vessels with which it is identified; but towards its superior termination it turns under the border of Poupart's ligament, and adheres to that of Gimbernat, with which it is inserted into the pectineal line. The pubic, or inner portion of the fascia (so called from its situation) lies on the pectineus muscle, and therefore is on a plane posterior to the femoral vessels. Superiorly, it terminates at the pectineal line, to which it is guided as it were by the muscle of that name; externally it passes behind the vessels and their sheath, and on reaching the border of the psoas muscle and its tendon, divides into two lamellæ. Of these, one rather dense and firm, passes deeply behind the tendon, and becomes attached to the fibrous capsule of the hip joint; the other, lying more superficial, unites along the border of the common tendon, with a membrane covering the muscles. This cannot be the fascia iliaca, as is usually stated. That membrane extends no farther than Poupart's ligament, in all that part between the spine of the ileum and the femoral vessels. In the rest of its extent, it forms part of the sheath of these vessels, behind which the pubic part of the fascia lata lies. The membranous structure then, with which this part of the fascia becomes blended at the border of the tendon, is a deep-seated layer of the fascia lata, prolonged upwards upon the iliacus and psoas muscles, and which finally unites with the under surface of the fascia iliaca, where the latter turns forwards to be connected with Poupart's ligament. The iliac and pubic parts of the fascia lata are continuous, and united at the lower border of the opening which their junction serves to form, and over which slides the saphena vein. Though the fascia, in the situation here referred to, appears to present a defined, concave border (the concavity looking upwards), it still will be found not to cease abruptly, on the contrary, it is folded on itself like the external margin of the opening, and reflected down on the sheath of the vessels, on which it is gradually lost. The oval aperture here described, from its transmitting the saphena vein, is called the *saphenous opening, (foramen saphenum)* and its curved external margin has been named by Mr. Burns the *falciform process.*

323. The description here given of this opening, and the statements concerning the manner in which the external and inferior parts of its border are folded and reflected, may be verified by dissecting it in the following way. We shall suppose for a moment that the skin has been carefully removed from the upper part of the fascia, so as to exhibit its two parts. The opening however is not defined, nor is its border distinctly seen. This is usually ascribed to the existence of a thin lamella, which is laid across the opening, and connected at each side with its borders. It is evidently of a reticular texture, and pierced by numerous small foramina, which transmit the superficial vessels, and thence named *fascia cribriformis.* It is considered as a part of the fascia lata, which however cannot be the fact; for the lower border of the opening is reflected down upon the sheath of the vessels, the external one is also reflected outwards upon it, whilst the inner part is prolonged altogether behind them. Hence no part of the membrane can be extended upwards in this situation. If the saphena vein be cut across an inch below the opening, and the fascia carefully divided by a transverse incision a little below its margin, the reflected layer can be observed as it passes down on the sheath of the vessels. Again, if from this incision another be made at right angles with it, and carried up to Poupart's ligament, the thin, reflected lamella sent outwards from what is called the falciform process, will be distinctly seen. If then, by the reflection of this border on the vessels, and the transmission of the pubic part behind them, the whole of the fascia is as it were disposed of, it follows that no third part remains to cover the opening, or to form what has been termed the cribriform lamella. What this really is will appear when we shall have examined the superficial fascia of the abdomen.

1. *Dissection of the anterior muscles of the thigh.* In order to expose the muscles on the fore part of the thigh (and it is with them the dissection usually commences) nothing more is necessary, after the skin has been removed, than to pinch up the fascia with the blades of the forceps, and divide it by successive steps from above downwards, in the direction of the fibres of each muscle. After the sartorius and rectus have been dissected in their entire length, and their attachments and relations attentively examined, the former may be cut across in the middle, and the parts drawn aside; the latter too may be divided near its origin, and turned down on the leg. The triceps extensor is thus brought fully into view, so that its three parts may be inspected successively, at the same time that it is considered as a whole. The muscle in fact may be compared to a hollow splint, encasing the anterior and lateral surfaces of the shaft of the femur, leaving unoccupied only the linea aspera and its bifurcations (superior and inferior). A perpendicular incision may, in the next place, be made through the muscle, extending from one extremity to the other over the middle of the femur. If the margins of the lateral parts be drawn aside, a clear view will be obtained of the manner in which the fibres pass to be implanted, by so many separate points, into the surface of the bone. Holding the border of the incision tense, and with the blade of the scalpel placed in the horizontal position, the muscle may be detached from the bone, after which the two parts, thus separated, may be turned down on the leg, still left connected with the patella. By these measures we shall bring into view the inferior attachments of the next set of muscles, which would otherwise lie in a great degree concealed. Before the extensors are detached and reflected, the form and boundaries of the opening for the femoral vessels should be attentively examined, as the vastus internus constitutes a part of it; nor should the membrane be omitted which passes from the latter muscle to the adductors, covering the vessels.

2. *Dissection of the internal muscles.* The direction and attachments of the adductor longus, running obliquely from the angle of the os pubis to the middle of the thigh, are at once obvious. The gracilis too will be observed running along its inner border. If the thigh be abducted, the fibres of these muscles will be rendered tense, and their dissection facilitated. The adductor longus

may be severed from its superior attachment, and drawn downwards on the femur. In doing this, its posterior surface will be observed to be connected to the adductor magnus for half an inch before their fibres reach the bone. The pectineus, lying to the outer side of the adductor, may in the next place be examined, and reflected after the same manner, which will bring into view the adductor brevis and the obturator externus. Whilst these measures are being executed, both surfaces of each muscle should be dissected, or, in other words, all the cellular tissue connected with them, should be removed by successive strokes of the knife, the edge being carried in the course of the fibres; and when their attachments, external conformation, and structure, have been thus fully made out, each of them may be again restored to its place, that their mutual relations and bearings may be re-considered. It is usual to direct that muscles, more especially the long ones, should be divided in the centre, and the two portions reflected. But if this precept be followed, it will be observed that students seldom examine, with any degree of accuracy, the points of attachment of muscles, without a precise knowledge of which, it is quite impossible to reason correctly on their action and uses. When a student is performing the dissection of the limb for the first time, it may be well if he confined his attention to the muscles, observing merely the general outline of the vessels and their branches, after which they may all be dissected away, in order to obtain an uninterrupted view of the muscles in their whole extent.

3. *Dissection of the posterior muscles.* The subject being placed in the prone position, and the abdomen supported on a high block, the foot should be rotated inwards, in order to put the gluteus on the stretch. An incision may be made through the skin, from the coccyx obliquely upwards over the side of the sacrum and posterior spine of the ileum, and as high as its crista. Another should run along the fold of the nates from the same point. The flap, thus included, should be dissected cleanly off the muscle in the course of its fibres, that is to say, downwards and outwards. The remainder of the skin which covers the pelvis, may be reflected upwards and outwards, the fascia serving as a guide. This will expose the tensor vaginæ and gluteus medius. The rest of the latter can be seen only when the gluteus maximus is detached. To effect this, let its lower border be drawn a little forwards, and

the scalpel inserted beneath it, so as to raise it from the sciatic ligament, and so successively from the side of the coccyx, sacrum, and ileum, proceeding from below upwards. When the muscle is detached, and turned down on the femur, the external rotators and gluteus medius come into view, and require little further dissection. As the gluteus medius covers the third muscle of that name, the easiest mode of reflecting it, is by cutting through its tendinous insertion, and drawing it upwards. The external rotators should be attentively examined, more particularly the two obturator muscles. The internal one cannot be fully seen until the pelvis is divided; but the direction of its two parts, and the peculiar appearance presented by its tendon, where it slides over the ischium, can be observed by cutting it across near its insertion, and reflecting it outwards. The origin of the flexors from the tuber ischii may be readily defined, and when their respective insertions are made out, that of the semi-membranosus should be particularly attended to, as it is attached to three distinct points. To gain a clear view of these the muscle may be cut across in the ham, and drawn down, when, by holding it tense, one set of fibres will be observed to pass along the inner tuberosity of the tibia, another obliquely behind the joint, whilst the third goes perpendicularly downwards, which, after being attached to the posterior surface of the tuberosity of the tibia, sends a dense fascia over the popliteus muscle, which is ultimately continuous with the deep fascia of the leg.

324. 2. *The fascia of the leg.* The lower part of the limb, from the knee to the ankle, is encased by a membrane similar in structure and use to that of the thigh. Posteriorly it is continuous with that part of the latter which covers the popliteal space, externally it contracts a firm adherence to the head of the fibula, where it is strengthened by additional fibres, sent down by the biceps muscle; and internally it receives an expansion from the sartorius. If traced down from these different points, the fascia will be found to invest the muscles, and also to send processes inwards between them, more particularly between the extensor communis and tibialis anticus in front, and on

the outside between the peroneal muscles. These intermuscular septa serve to increase the number of points to which the muscles are attached; for it will be observed that their fibres arise from them, as well as from the inner surface of the fascia for some way down the leg. The fascia is thin posteriorly over the gastrocnemius, but is dense and firm where it covers the extensors, more particularly at the upper part; and will be found so firmly united along the anterior angle of the tibia, that it cannot be detached so as to be traced over its cutaneous surface. If traced along the posterior aspect of the leg, the fascia will be observed to pass over the tendo Achillis, and to be connected with the malleoli on each side, and also with the fibrous sheaths which bind down the tendons passing behind them. On the inner side it joins the internal lateral ligament, externally it is continuous with the fascia covering the side of the foot, and in front becomes identified with the anterior fasciculus of the anterior annular ligament.

Dissection of the muscles of the leg. These, to facilitate their classification, may be divided into sets, each consisting of three muscles. Thus, on the fore part of the leg, and lying between the tibia and fibula, we find the tibialis anticus, the extensor communis, and extensor pollicis, which can readily be exposed by dividing the fascia, and dissecting it off the muscles proceeding from below upwards, taking the tendons as a guide. On the external side of the leg, and in close contact with the fibula, are placed the peroneus longus and brevis. The third muscle of this name is, in reality, a part of the extensor communis, and is separated from the others by the breadth of the fibula. It still however is described as a separate muscle, probably to keep up the ternary division. The same rule will suffice for dissecting these, as for the extensors. On the posterior part of the leg there are two sets, one superficial, the other deep-seated. The former consists of the gastrocnemius, the soleus, and plantaris. These can be exposed without any difficulty, by dissecting off the fascia, commencing where it is continuous with that covering the popliteal space; after which the internal head of the gastrocnemius may be raised, and its border reflected outwards. By this expedient the thin tendon of the plantaris will come into view, and afford a guide to its muscular belly, which may otherwise be raised with the external head of the gastrocnemius, with which it is closely in contact. The soleus may in the next place be detached, taking the inner surface of the tendo Achillis as a guide; previously to which, attention should be directed to the structure of that part of its upper border between its tibial and fibular origins, which is arranged for the transmission of the posterior tibial vessels. The deep-seated set now become exposed, viz. the flexor communis, placed along the tibia, the flexor pollicis on the fibula, and the tibialis posticus between both, and partly concealed by them. The popliteus alone remains to be noticed, being, from its position behind the joint, excluded from the groups of muscles appertaining to the leg. From its lower border a membrane extends downwards, binding down the deep muscles, and connected on each side with the borders of the bones, and, towards the ankles, with the sheaths of the tendons; and if traced along the interval between the inner ankle and the heel, it will be found to cover the vessels, and to terminate at the internal annular ligament.

325. The fasciæ of the foot consist of two parts, differing in density and texture as well as in situation, one being a dense fibrous structure, placed in the sole of the foot, the other a thin membrane covering its dorsum. Previously to examining the latter, it becomes necessary to describe a band of fibres, which is strained across the bend of the ankle, and serves to bind down the tendons of the muscles. *a.* The *anterior annular ligament* is attached by one extremity to the external malleolus, and to the depression on the upper surface of the calcaneum, from which points, the fibres of which it consists, pass obliquely inwards, and divide into two fasciculi on reaching the border of the peroneus tertius and common extensor, one of them passing in front, the other behind the tendons of these muscles. At their inner border, the fasciculi become united again, thus forming a tube or sheath for the transmission of the tendons. A similar arrangement of these fasciculi obtains as

the outside between the peroneal muscles. These intermuscular septa serve to increase the number of points to which the muscles are attached; for it will be observed that their fibres arise from them, as well as from the inner surface of the fascia for some way down the leg. The fascia is thin posteriorly over the gastrocnemius, but is dense and firm where it covers the extensors, more particularly at the upper part; and will be found so firmly united along the anterior angle of the tibia, that it cannot be detached so as to be traced over its cutaneous surface. If traced along the posterior aspect of the leg, the fascia will be observed to pass over the tendo Achillis, and to be connected with the malleoli on each side, and also with the fibrous sheaths which bind down the tendons passing behind them. On the inner side it joins the internal lateral ligament, externally it is continuous with the fascia covering the side of the foot, and in front becomes identified with the anterior fasciculus of the anterior annular ligament.

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they cross the tendons of the extensor proprius and tibialis anticus, so that each is made to pass through a separate tube; and finally the fibres of the ligament, after having been thus successively separated and united again, are inserted into the internal malleolus. Now the fasciculus of this band, or ligament, which lies in front of the tendons, is continuous by its upper border with the fascia of the leg, and by the lower with that on the dorsum of the foot, all three lying on the same plane beneath the skin. *b.* The *internal annular ligament* is attached by one extremity to the inner malleolus and the fibrous sheath of the muscles passing behind it, by the other to the inner margin of the calcaneum. Its superior border is continuous with the fascia of the leg, the inferior gives origin to part of the abductor pollicis; one surface is subcutaneous, the other is in contact with the vessels which pass under cover of it into the sole of the foot.

326. 1. The *fascia on the dorsum of the foot* covers the extensor tendons, being prolonged from the lower border of the annular ligament forwards, to the digital phalanges. When traced towards the external border of the foot, it is found to be attached to the head of the fifth metatarsal bone. Behind that point, it becomes blended with the corresponding margin of the plantar fascia, and before it, the membrane folds over the abductor and short flexor of the little toe, and unites with the digital process of the plantar fascia that lies beneath them. When traced along the inner border of the foot, we find the membrane passing over the fleshy fibres of the abductor pollicis. Posteriorly it is attached to the calcaneum; but in all that part called the hollow of the foot, after covering the muscle just named, it is folded round its outer border, and, for part of its extent, passes deeply towards the tarsal bones, becoming blended with a septum, sent upwards by the plantar fascia; in the rest it unites with the first digital process of the fascia just named. The correctness of these statements may be rea-

dily ascertained by dissecting the fascia from the tarsal bones, and tracing it over the border and plantar surface of the abductor muscle, when its termination and attachments will be found to be as above stated.

327. 2. The *plantar fascia* is a dense fibrous structure, extended from the calcaneum to the heads of the metatarsal bones, occupying the sole of the foot. It is attached posteriorly to the posterior tubercles, on the plantar surface of the calcaneum, where its fibres are aggregated into an arrow, thick fasciculus. From this point the fibres, as they proceed forwards, diverge and arrange themselves into two parts separated by a depressed interval, one corresponding with the muscles of the little toe, the other with the middle of the tarsus, and the whole width of the metatarsus. The external, or narrow part, after being connected firmly with the fifth metatarsal bone, sends forwards some thin fibres which unite with the last digital process of the larger portion. By its outer border it gives attachment to the fascia of the dorsum of the foot, from the other it sends a process upwards to the tarsal bones, which contributes to form a septum between the plantar muscles. The larger portion of the fascia becomes thin as its fibres diverge, and ultimately resolves itself into five processes corresponding with the metatarsal bones. Each process, on reaching the digital extremity of these bones, divides into two fasciculi, which separate and become attached to their sides, thus leaving an angular interval for the transmission of the tendons and vessels to the phalanges of the toes. From each border of this part of the fascia a membranous partition is given off, which separates the mass of muscles placed in the middle of the foot, from those that are situated along its borders, and belong to the great and little toes. These septa are not merely interposed between the lateral and middle bundles of muscles. Their points of attachments to the tarsal bones will be found connected by a thin fascia passing across from one to the other, separating the flexor

brevis digitorum from the long flexors, and bearing the same relation to the latter that the deep fascia of the leg does in the rest of their extent. If the middle, or broader portion of the fascia be divided by an incision carried from behind forwards, and the two parts reflected to each side off the flexor brevis, the septa will be observed passing upwards; and, if that muscle be drawn aside, the deep fascia will come into view. It may be proper to observe, that the plantar fascia is usually said to consist of three portions, the lamella that covers the great toe being considered as one. But this will be found, if examined in the way already pointed out, to be a prolongation from the fascia on the dorsum of the foot, to which its structure is strictly analogous, and, therefore, altogether different from that of the plantar fascia.

The Membranes of the Abdominal Parietes.

328. The muscular parietes of the abdomen, it will be recollected, consist of three lamellæ, made up of fibres placed one over the other. The arrangement of these fibres, in the greater part of their extent, is well calculated to support the viscera, and prevent their protrusion. The external set incline downwards and inwards; those subjacent to them run in the opposite direction, whilst the internal ones take a transverse course, so that they afford to each other a mutual support. But this arrangement does not obtain throughout the entire extent of these muscles. In the lower part of the abdomen the fibres of the muscles are quite differently disposed; they all incline downwards and inwards, and thus lose the advantage obtained by the arrangement above noticed. The fibres also of the two inner muscles, in this part, are thin and pale, and, moreover, an interval is left beneath their lower border for the passage of the spermatic cord of the male, and round ligament of the female. In the external muscle also, an aperture is formed for the transmission of the same parts.

Again; Poupart's ligament being merely stretched across from the spinous process of the ileum to the pubis can only be contiguous to, or in apposition with the parts which pass beneath it from the abdomen down to the thigh, viz. the psoas and iliacus muscles and the femoral vessels. These are obviously so many sources of weakness—so many deficiencies in the structure of the part, which, if not guarded against by some additional provision, would leave us constantly exposed to the occurrence of intestinal protrusions both above Poupart's ligament and below it.

329. Before we enter on the description of the accessory structure, whose existence is here indicated, or rather the necessity of which is inferred, it becomes necessary to premise a few remarks on the method of dissecting the parietes of the abdomen, and also on certain subdivisions of that cavity which have been adopted by anatomists. It contains many and important parts, whose situation and mutual relations require to be minutely described, and which, when diseased, give rise to a variety of symptoms that demand a rigorous scrutiny. For these reasons, pathologists have found it necessary, in order to give precision to their inquiries, as well as clearness to the communication of the results of them to others, to adopt those subdivisions which anatomists had established for the purpose of facilitating their descriptions of parts. With these views the cavity of the abdomen has been divided into three primary regions, a superior, an inferior, and a middle, which is intermediate between both. These may be marked out by two transverse lines drawn round the body, as follows: one having commenced at the most prominent point of the cartilages of the ribs at one side, is drawn across to the corresponding point on the opposite, and so continued round the spine, to the place at which it began, thus completing the circle. The other line, proceeding from the crista of the ileum at one side, extends to that of the other, and so round the body, as in the former instance.

The superior division, or zone, is called, from its position, the *epigastric region* (επι, *above* or *upon*, γαστηρ, the *abdomen*). Its lower boundary corresponds with the line above indicated, the upper, with the ensiform cartilage, and the diaphragm. The inferior division has been named the *hypogastric region* (ὑπο, *under* or *beneath*, γαστηρ, the *abdomen*) which extends from the lower transverse line to the crista of the pubis, and to Poupart's ligament on each side. The intermediate, or middle division, is called the *umbilical region*, from the circumstance of the umbilical aperture being placed at its centre. These divisions not having been found sufficient for the purposes above stated, it became necessary to subdivide each of them into three minor regions, which may be done by drawing two lines parallel to one another, from the cartilage of the eighth rib down to the centre of Poupart's ligament. By this expedient each primary region is divided into a central and two lateral ones. The epigastric region is thus resolved in the two *hypochondriac regions* (ὑπο, *under*, χονδρος, the *cartilage*) and the proper epigastric region, which is sometimes called scrobiculus cordis. The middle zone is divided into the proper *umbilical* region in the centre, and the two *lumbar* regions on each side; and the inferior zone into the proper hypogastric or pubic region in the centre, and the *iliac* regions on each side.

330. The mode of subdividing the primary regions here suggested differs from that adopted by others. The vertical lines are invariably directed to be drawn from the most prominent point of the costal cartilages, to the anterior superior spinous process of the ileum. It must be obvious that the very purpose and intent of marking out these lines shew that they are not confined to the surface on which they are drawn. They are, on the contrary, supposed to be projected into so many planes, forming partitions, which divide the cavity into compartments, each containing a certain portion of the abdominal viscera. Now, if lines were

drawn from the costal cartilages to the spine of the ileum, they would exert no influence on the hypogastric region, inasmuch as they cease at its upper boundary; and in the next place, if projected backwards, they would leave the lateral parts of the umbilical region far too small. These reasons, it is hoped, will sufficiently warrant a departure from usage and precedent.

Dissection of the abdominal muscles.—When commencing the dissection of the abdominal muscles, an incision may be made through the skin from the ensiform cartilage to the umbilicus, and another from thence to the most depending part of the margin of the thorax. The angular flap of skin, bounded by these lines, may be easily reflected by commencing at its point, and taking the tendinous fibres of the external oblique muscle as a guide, each stroke of the scalpel being directed obliquely upwards and outwards. The flap should be reflected until its base, or attached border, is brought on a line with the ensiform cartilage, which is necessary, in order to expose the digitated processes of the muscle, and their intermixture with those of the serratus magnus. An incision may, in the next place, be carried horizontally inwards from the anterior superior spinous process of the ileum to the linea alba, and there met by another drawn down from the umbilicus. The enclosed flat part of skin should be reflected back to the posterior part of the lumbar region. If it be required to exhibit the muscle in its entire extent, the portion of integument still remaining on the lower part of the abdomen may be divided by an incision drawn from the pubis upwards, and the flap reflected down over Poupart's ligament. For the present, however, we shall leave untouched the integument, muscle, &c. in the iliac region, as they will require to be examined attentively when treating of the dissection of the parts connected with hernia. The external oblique muscle may be detached and reflected so as to bring into view the one subjacent to it, by cutting through its muscular fibres, midway between its digitations and the margin of the ribs. Its posterior, or free border, will be found extending from the last rib to the crista of the ileum, and can be readily distinguished from the internal oblique muscle by the different course of its fibres. When this is effected, the fleshy fibres can be dissected from the crista ilei, as far as its spine, and the whole plane of muscle turned over to the opposite side. The internal oblique is thus exposed for two-thirds of its extent. When its examination has been completed it is said to be difficult to detach it without injuring the muscle beneath it; yet, if in any part above the spine of the ileum, the fibres be rendered tense by pressing the thumb and fore-finger of the left hand on them, and so straining the interval, they can be divided with perfect precision, without interfering with the subjacent muscle; for the fibres are retracted when divided, and after about three parts are cut through, the cellular interval between the muscles begins to be perceived, which, with the difference in the direction of their fibres, affords an unerring guide to their line of separation. Near the spine and crista of the ileum, these muscles are also separated by the circumflexa ilei vessels, and this is the part usually selected for cutting through the internal oblique, in order to expose the transversalis. When the line of separation is found, the muscular fibres should be detached from the crista ilei as far back as to where they end in the fascia lumborum; after which they may be dissected from the cartilages of the ribs by insinuating the scalpel between the two planes of fibres, and then turning it so as to cut outwards. In this way the internal oblique muscle may be detached from its connexions, and reflected to the opposite side, exposing the transversalis.

The sheath of the rectus muscle should in the next place be examined. Its mode of formation has been fully described, (sect. 206). Its anterior layer may be divided in its whole length, by an incision drawn down from the margin of the thorax to the pubis, and reflected off the rectus. By inserting the handle of the scalpel beneath the outer border of the muscle, it may be raised, and the posterior layer of the sheath brought into view Lastly, if the muscle be cut across midway between the umbilicus and pubis, and the two parts drawn aside, the point at which the sheath is imperfect posteriorly, can be determined by pushing the handle of the scalpel against it, so as to separate it from the subjacent membrane.

We have described (sect. 209,) a membranous prolongation from the internal oblique and transversalis muscles as forming an investment for the quadratus lumborum, similar in many respects to the sheath of the rectus. Let us suppose that it is intended to examine this structure on the right side; it then will be found convenient to lay the subject on the left, and to have it secured in that position. If the internal oblique be traced back, its muscular fibres will be found to end in an aponeurosis, which becomes intimately connected with the inner surface of the latissimus dorsi, close to the border of the deep lumbar muscles. Now, if the aponeurosis of the latissimus be divided, in the middle of its breadth, by an incision drawn from the ileum to the last rib, and the two parts reflected, the thick mass of lumbar muscles will be exposed, and if the handle of the scalpel be inserted beneath their outer border, they will be found to lie on a membrane, which is connected with the lumbar vertebræ on the one hand, and with the abdominal muscles on the other, being in fact a prolongation of the latter. The mass of lumbar muscles may now be cut across, opposite the last rib, and at the crista ilei, and removed altogether. When this is effected, if the attention be directed to the internal oblique muscle, it will be found that the fascia in which it ends posteriorly, divides into two lamellæ, one being connected with the aponeurosis of the latissimus dorsi, and with it carried to the spinous processes of the vertebræ behind the lumbar muscles, whilst the other proceeds to the points of the transverse processes. Again, if the latter lamella be divided by a perpendicular incision from the last rib to the ileum, and reflected outwards, the quadratus lumborum muscle will be exposed; and, if its external border be raised, another lamella will be found covering its abdominal surface, and connected with the roots of the transverse processes. To the aggregate of these processes of membrane, thus sent back to the lumbar vertebræ from the internal oblique and transversalis muscles, the term *fascia lumborum* is applied.

The subject, when this part of the dissection has been completed, may be turned on its back, in order that the inguinal region may be examined, which is an indispensable preliminary to a correct knowledge of the structure of the parts connected with those intestinal protrusions to which the term hernia is applied (ἕρνος, *a tumour*). It will be recollected that an angular flap of integument still remains, covering the iliac region. The skin alone should be raised over this part, and reflected down on the fore part of the thigh, for about four inches below Poupart's ligament, without disturbing the layer of cellular membrane that lies beneath it. This we shall now proceed to describe as the superficial fascia of the abdomen.

331. The *superficial fascia* (*fascia superficialis*) is a layer of cellular membrane placed between the skin, and the external oblique muscles, in their entire extent, and which is moreover prolonged upwards over the thorax, down on the thighs, and backwards into the loins. It is in fact part of the subcutaneous cellular membrane which we find all over the body; but in the region here referred to, it deserves particular attention, from its forming one of the coverings of hernial tumours. In the human subject it can add little to the strength of the abdominal parietes; but in animals, particularly in the larger quadrupeds, its place is occupied by a membrane of a yellow colour, firm texture, and quite elastic, which assists the muscles materially in supporting the viscera. Its structure in these cases is closely analogous to that of the ligamenta subflava of the vertebræ, or to the middle coat of arteries, according to the opinion of those who deny them muscularity. The superficial fascia increases in thickness towards the lower part of the abdomen, and in its substance may be observed to run the superficial epigastric vein and artery, so that along their course, it may, by a little care, be separated into two lamellæ, but on each side of the vessels it remains single, and undivided. Taking the vessels as a guide, the anterior lamella of the fascia can be dissected off them as far down as the saphenous opening in the fascia lata, and thence onwards uninterruptedly over the thigh. Externally, where the membrane is undivided, it can be traced over the iliac part of the fascia lata, and internally over the spermatic cord, and so to the scrotum, forming one of its layers, and thence down into the perinæum. When raised from the aponeurosis of the external oblique, and reflected down, together with the small vessels which lie upon it, we

find it closely connected by cellular bands with the line of junction between the iliac portion of the fascia lata and Poupart's ligament, and further down it becomes connected with the borders of the saphenous opening, being stretched across from one to the other, so as to form that *cribriform lamella* through which the superficial vessels pass, and which, for the reasons already stated, when describing the fascia lata, cannot be considered as a part of that membrane.

332. The aponeurosis of the external oblique muscle being exposed by the removal of the superficial fascia, the fibres which compose it will be observed gradually to separate as they approach the crista of the pubis, and to be aggregated into two bundles, leaving an interval between them, as they pass, the one to the pubic symphysis, the other to the tuberosity of the pubis. This interval must therefore be of a triangular form, its base corresponding with the crista of the pubis, and the sides with the two bundles of fibres above referred to. This has been called the *external abdominal ring*,—a term evidently ill-chosen, if its form be considered, more particularly as its bounding lines are named *pillars*. Towards the crest of the pubis a rounded cord (*spermatic*) projects through the opening, but its borders or pillars are not distinctly defined, which is owing to the circumstance of a membrane being stretched across from one to the other, and also prolonged on the cord. If the surface of the aponeurosis of the external oblique be examined, a series of fibres will be observed running upon it and describing arches, the convexity of which looks downwards and inwards. As they approach the triangular aperture they become more closely aggregated together, and lose their fibrous character, so as to assume that of a smooth membrane, which passes thence downwards on the cord, forming one of its investments. Whilst resting on the fibres of the muscle, this structure is called the *intercolumnar fascia*, and where it comes into contact with the

cord, it receives the name of *fascia of the cord*, or *fascia spermatica*. This thin fascia may be detached from the cord, so as to exhibit clearly the margins of the pillars, by holding the cord forwards, and lightly drawing the edge of the scalpel all round it, so as to divide the fascia, after which it can be readily pushed upwards.

333. The aponeurosis of the external oblique muscle may, in the next place, be divided by an incision carried horizontally inwards from the anterior superior spine of the ileum, to the linea alba, from the termination of which another should be drawn down to the pubes. The angular flap thus included may then be reflected down on the thigh, by which means the internal oblique muscle is brought into view, and also the cremaster, which is given off from its lower border, and thence prolonged upon the cord, with which it passes through the opening in the external oblique muscle. The cord lying undisturbed in its situation; will be observed to rest, (so far as it is exposed by reflecting the external oblique) upon the fibres of the internal oblique, after having passed beneath its lower border. For the same extent it is covered by the aponeurosis of the external oblique, and inferiorly it is supported by the groove formed by the lower fibres of the latter, as they turn obliquely backwards and inwards to reach their second and third insertions. Supported in this groove to the point at which it passes through the external ring, the cord will be observed to incline a little outwards, after its exit, and to lie to the outside of the tuberosity of the pubis. To expose the cord in the rest of its extent, it becomes necessary to detach the fibres of the internal oblique muscle from the inner surface of Poupart's ligament, and to reflect them, together with the cremaster, towards the middle line. This requires to be done with care, in order to separate them from the transversalis muscle, whose fibres in this part run in the same course, both being also inseparably united previously to their insertion into the crista of the pubis. When

this is effected the cord will be found to pass beneath the lower fibres of the transversalis muscle, where they form an arched border over it; and if these fibres be carefully pushed upwards, by passing the handle of a scalpel beneath them, a thin membrane will be brought into view, on which the muscle, last named, rests. Through this membrane the cord passes; in doing so, however, it does not pass through it, as it might be supposed to do through a hole in a sheet of paper, or, in other words, through an aperture with a sharp and defined border. On the contrary, the cord in its passage carries with it, from the margin of the opening, a prolongation which runs down upon it, inclosing it all round, and gradually narrowing so as to become of a funnel-shape. Now, if the fibres of the transversalis be detached a little farther, an artery (the epigastric) will be observed running from below upwards, lying to the inner side of the cord, at the point where the latter pierces the membrane. This, it may now be observed, is called the *fascia transversalis*, from lying behind the muscle of that name, and forms part of a general lining placed within the abdominal parietes.

334. The cord, then, in its passage, lies in an oblique canal, formed for it in the wall of the abdomen; its direction being downwards, inwards, and forwards. Its length varies from an inch and a half to two inches, in different instances; it presents an inlet, an outlet, and an intervening space, viz. the canal itself, each of which requires a special notice. The inlet or inner aperture of the canal (*the internal abdominal ring*) is situated in the fascia transversalis, being that part of it through which the cord passes, as it is about to emerge from the cavity of the abdomen. It corresponds with the middle point between the anterior superior spinous process of the ileum, and the symphysis pubis, being about half an inch above the margin of Poupart's ligament. Its existence may be determined, and its margins defined, or rather, margins may be given to it, by holding the cord

forwards, and cutting across the prolongation which it receives from the fascia. When the cord is relaxed, the aperture becomes apparent. The outlet, or the inferior and external opening, (*the external abdominal ring*) is the triangular interval left between the fibres of the external oblique muscle, which has been already described; the canal itself being formed by the different structures which compose the parietes of the abdomen. At the point above indicated, viz. midway between the anterior superior spine of the ileum and the pubic symphysis, the spermatic vessels and the vas deferens meet at an angle. They there pierce the fascia transversalis, as has been already stated, and receive from it their first investment, viz. the funnel-shaped process given off from the margin of the internal ring. Thus inclosed, they turn downwards and inwards, under cover of the transversalis muscle, and then under the internal oblique. During this part of its course, which is about one-third of the length of the canal, the cord rests on the fascia transversalis, and is covered immediately by the muscles just mentioned. Whilst passing from under the lower border of the internal oblique, it receives its second covering, the cremaster muscle, and during the rest of its course through the canal, it lies upon the conjoined fibres of the internal oblique and transversalis muscles, (where they turn down to be inserted into the crest of the pubis and the pectineal line), and is covered by the aponeurosis of the external oblique. At the external ring its third investment is placed upon it, viz. the intercolumnar fascia, or fascia of the cord, after which it becomes covered by the superficial fascia and the common integument. These different structures are examined with attention by anatomists, not so much from a consideration of any importance or interest they possess in the natural or healthy condition of the parts, but by reason of the relation which they bear to hernial tumours, when they occur in this situation. Five lamellæ, it will be recollected, have been here enumerated, as forming investments to the cord. They have been taken in the order in which the cord and testis come into contact with them, whilst passing from the abdomen down into the scrotum. Should a portion of intestine be forced through the internal ring into the canal, and so down into the groin, it will, during its progress, clothe itself in these same investments, together with another derived from the peritonæum, which it pushes before it, at the moment of its exit. Hence it is, that the anatomist describes these structures in the order in which they are super-imposed upon the cord, or the hernial sack; the surgeon, on the other hand, enumerates them in the order in which they successively present themselves to his scalpel, whilst he is dividing them during an operation.

335. When the intestine follows the course of the canal, the tumour which it forms is denominated, from its situation and direction, *oblique inguinal hernia*. In such cases the neck of the sack lies close to the external side of the epigastric artery, on which account Hesselbach has applied the term *hernia externa* to that form of the affection now under consideration. On the inner side of the epigastric artery a triangular space will be observed, its sides being formed by that vessel, and the external border of the rectus muscle, and its base by the crista of the pubis and the part of Poupart's ligament intercepted between its tuberosity and the epigastric artery. Across the area of this space are stretched the conjoined fibres of the internal oblique and transversalis muscles, which, even with the addition of the fascia transversalis, would form an inadequate support to the viscera in this situation, particularly as the external oblique cannot lie evenly upon them, owing to the interposition of the cord. By a little attention a number of white tendinous fibres may be observed to pass obliquely upwards and inwards from about the inner fourth of Poupart's ligament, as well as from the crista of the pubis; and after crossing the area of the triangular space, to terminate

by being inserted into the linea alba. These, by being stretched between the points just referred to, and by running across the fibres of the internal oblique and transversalis muscles, with which they are in close contact, tend materially to support them. But this is not the only influence they seem to exert. If the fibres of the external oblique be cut through, so that no part be allowed to remain but the external pillar of the ring, and Poupart's ligament, it is clear that no direct communication any longer exists between the latter and the linea alba. Now, if the linea alba be pushed to the opposite side, or if it be cut across, and drawn in different directions, by being held in the forceps, Poupart's ligament will be made tense and elevated by the traction exerted upon it, through the medium of the oblique fibres here described. These fibres then serve not only to strengthen the part over which they are extended, but also to connect the linea alba and Poupart's ligament, somewhat on the principle of a diagonal brace, and by means of their elasticity tend to weaken the force of any pressure made upon the part by diffusing it over a greater extent of surface. Should the intestine protrude in this situation, it must either distend and push before it the conjoined fibres of the transversalis and internal oblique muscles, together with those last described, or it may rupture some of them, and escape through the interval. In either case, it passes directly forwards through the external ring, and hence has been denominated *direct inguinal hernia.* But Hesselbach calls it *hernia interna,* from its relation to the epigastric artery. A correct and clear knowledge of the direction and formation of the inguinal canal can alone enable the surgeon to apply the taxis judiciously in cases of oblique hernia. And a knowledge of the precise situation of the internal ring is no less necessary to point out the exact spot on which the pad of a truss should be applied to prevent the recurrence of a hernial protrusion.

336. After having thus described all that part of the inguinal region which lies above Poupart's ligament, the iliac portion of the fascia lata may be divided by a transverse incision, and drawn outwards. The lower border of the ligament may in the next place be defined by passing the handle of a scalpel beneath it. When this is done, a funnel-shaped membranous tube will be observed passing down behind it, narrowing as it descends, and investing the femoral vessels. If some of the superficial inguinal glands have been retained, their vasa efferentia may be readily seen (by drawing the glands down, and so rendering the vessels tense,) to pierce the inner side of the tube, and so render it cribriform. This tube, by a little care, can be insulated from Poupart's ligament, which lies before it, from the border of Gimbernat's ligament, which is situated to its inner side, and from the pubic portion of the fascia lata, on which it rests; and if it, together with the inclosed vessels, be cut across two inches below Poupart's ligament, they may easily be drawn up towards the abdomen. These facts bear materially on the anatomy of the parts connected with crural hernia.

337. When the examination has been conducted thus far, the abdomen may be laid open by making an incision from the umbilicus to the anterior superior spine of the ileum on each side, and drawing the whole flap down on the thighs. The intestines should, in the next place, be removed, and the peritonæum carefully detached from the iliac fossa, and from the inner surface of the flap above described, as well as from the lumbar region. When this has been done, the inner surface of the parietes of the abdomen will be found to be lined throughout its entire extent by a smooth, shining membrane, which appears to be placed there for the purpose of strengthening them where they are most in need of support, and of connecting them together, where, from the fact of its being merely contiguous, they are liable to be separated from each other,

and so leave spaces into which the intestines may be protruded. This membrane, on a first inspection, would appear to form a cul-de-sac, its closed extremity being placed at the lower part of the cavity,—one side of it being prolonged upwards behind the transversalis muscle, the other backwards upon the iliacus, the juncture or seam marking the union of the two being at Poupart's ligament. However, when examined with attention, it will be found not to form a complete shut sack at the lower part of the abdomen, for a prolongation of a tubular form descends from it, round the femoral vessels, so as to become continuous with the sheath that invests them in the rest of their extent. Again, where the spermatic vessels pass from the abdomen into the inguinal canal, they also receive a tubular investment, which accompanies them. Both these, it will be recollected, have been brought into view during the progress of the dissection of the external parts already directed. The membranous lining is not usually described in this way as a continuous whole. Its different parts are examined separately and with much detail, so that students are apt to regard them as distinct structures, and probably intended for different purposes, more especially as each has been designated by a particular name. For instance, all that part of the membrane which lies above Poupart's ligament, and lines the transversalis muscle, has been from that circumstance named the *fascia transversalis.* The posterior part which rests on the iliacus muscle has been, doubtless for a similar reason, called the *fascia iliaca;* and where the membrane is prolonged over the margin of the pelvis, it receives the name of *fascia pelvica.* Finally, where it becomes reflected upon the sides of the rectum and bladder, some have gone so far as to call it the *vesical fascia.* These, it may be observed, are anatomical or topographical names taken from the situation of the different parts of the membrane. There are others, however, which have a surgical origin, (if such an expression be allowable) inasmuch as they are derived from their connexion with pathological conditions of the parts, or, in other words, with certain forms of hernia. Thus the tubular prolongation, already noticed as descending upon the femoral vessels, has been termed the *fascia propria* of crural hernia; and that which passes along the spermatic cord, has been by some considered as the *fascia propria* of inguinal hernia. With this general view of that structure, which we have here ventured to term the membranous lining of the abdominal parietes, we proceed to describe, ***seriatim et singulatim***, the different portions into which it is usually divided.

338. 1. The *fascia transversalis* has been so called by Sir Astley Cooper, (who discovered it) from its being placed behind the transversalis muscle, which it lines. Some degree of confusion occasionally arises from the use of this term. For whilst describing the different parts of this region, we are obliged to speak of the transversalis muscle, —the conjoined fibres of the transversalis and internal oblique—the aponeurosis of the transversalis, and, finally, of the fascia transversalis. The repeated use of the same term, in so many different acceptations, produces no small degree of perplexity, particularly to students at the commencement of their pursuits. We may then take one step at least towards removing a source of embarrassment to ourselves, at the same time that we make a due acknowledgment to the individual whose researches have thrown so much light on the anatomical structure of the parts connected with hernia; and as he was the first who discovered and described the membrane now under consideration, it may with great propriety be called *fascia Cooperi*. The fascia transversalis, or fascia Cooperi, then, is a thin smooth membrane, closely adhering to the transversalis muscle; along whose inner surface it may be traced, in many instances, upwards as far as the margin of the ribs, gradually becoming thinner as it ascends above the umbilicus; down-

wards it reaches to Poupart's ligament, and the pubic symphysis, and outwards it extends to the crista ilei, (to which it is firmly attached). Finally, if examined above this point of bone, it will be found prolonged deeply into the lumbar region as far as the anterior lamella of the fascia lumborum, on which it gradually degenerates into cellular tissue. As the membrane extends inwards to the middle line (for we here confine our attention to one lateral half of it,) it becomes closely adherent to the aponeurosis of the transversalis muscle, and where it lies behind the rectus, it becomes thin and weak. If from this point it be traced downwards, it will be found, after lining the rectus, to pass along the inner surface of the pubic symphysis, and thence down to the point at which the urethra escapes from the pelvis, where it is reflected backwards upon the upper surface of the neck of the bladder, on which it is gradually lost. Along the lower border of the abdomen the membrane may be said to terminate at Poupart's ligament, at least in all that part of its extent which is included between the anterior superior spine of the ileum and the exit of the vessels, where, by uniting with the fascia iliaca, it forms a complete cul-de-sac, the junction being indicated by a white line running from without inwards; but this does not exactly correspond with the margin of Poupart's ligament. Now in that space which is included between the external border of the femoral artery, and the base of Gimbernat's ligament, the membrane cannot pass backwards to join the fascia iliaca, inasmuch as the vessels are interposed between them. Hence it is prolonged down behind Poupart's ligament, guided as it were by the vessels, and forming the anterior half of the membranous tube that invests them, and which has been already more than once alluded to.

It will be recollected that the fascia transversalis forms the entire of the smaller prolongation that invests the spermatic vessels, as they escape through the internal ring. When describing the last named opening, no mention has been made of its boundaries, or its pillars, as they have been called. It is difficult to conceive the existence of any thing so dense or defined, as to resemble a pillar, in a membrane so thin and uniform in its structure. Most probably a consideration of the structure of the external ring led to the idea that it was necessary to institute an analogy between it and the internal one, and so to assign pillars to the one as well as the other.

339. 2. The *fascia iliaca* is more dense and firm than the membrane just described. It is in close contact with the iliacus muscle, and, like it, is attached to the inner margin of the crista ilei from the anterior superior spine backwards for three-fourths of its extent, and, so far, it is continuous with the fascia transversalis, which has been described as being inserted along that line. When traced inwards, it is found to pass behind the iliac vessels and over the psoas muscle, along the inner border of which it sinks into the pelvis. Round the margin of this cavity the fascia becomes closely connected to the bone by means of dense cellular fibres, after which it descends, lying upon the inner surface of the obturator internus muscle, until it comes to a level with an oblique line, extended from the symphysis pubis to the spine of the ischium. At the point here indicated the fascia turns inwards guided, by the pelvic surface of the levator ani muscle, and so reaches the side of the rectum and bladder, with which it becomes identified. In the interval between the spine of the ischium and the promontory of the sacrum, the fascia stretches across the great sciatic notch, covering over the parts which escape through it; and as it lies behind the internal iliac artery, it must be pierced by its different branches, giving to each a tubular prolongation. On reaching the surface of the sacrum the fascia becomes continuous with that of the opposite side.

It may thus be observed that the psoas muscle is covered by the fascia as well as the iliacus. We have as yet traced it upon the former no higher than where it is on a line with the crista ilei. But the fascia does not cease at this point, it extends upwards on the muscle, being prolonged, from its surface, inwards upon the lumbar vertebræ, whilst, along its external border, it is united with the fascia lumborum, and terminates superiorly, by being inserted into the ligamentum arcuatum. Thus we find that the numerous interstices, apertures, and foramina, which occur in this extensive region, are covered over by this membrane. We now proceed to examine that part of it which is more immediately connected with the anatomy of hernia.

340. When traced to the lower margin of the abdomen, the fascia iliaca is found to turn forwards a little, and to become blended with the fascia transversalis in all that part of its extent which intervenes between the anterior spine of the ileum and the exit of the femoral vessels. But in the interval, between that point and the base of Gimbernat's ligament, the fascia cannot come forwards so as to form a junction with the fascia transversalis, in consequence of the interposition of the vessels, on which account it passes down behind them, forming the posterior part of their funnel-shaped investment. Having thus derived the part of this membranous tube that lies before the vessels, from the fascia transversalis, and that which is behind them from the fascia iliaca, it remains only to add, that its lateral borders are formed by the junction of these membranes along the external side of the artery, and at the base of Gimbernat's ligament, by which means the tube is completed. The tube is wide above, but gradually narrows as it descends. The external border runs straight downwards along the artery, to which it is closely applied; the internal one inclines obliquely downwards and outwards, from the base of Gimbernat's ligament, so as to reach the vessels. The external part of it only is thus found occupied by the vessels, the remainder is unoccupied (except by a lymphatic gland) and presents an oval opening called the *crural ring*, which is the only outlet that exists beneath Poupart's ligament,

through which a portion of intestine can be protruded. Such an accident cannot happen immediately in front of the vessels, for we find interposed between them, and connecting the anterior to the posterior sides of the tube, a firm process of membrane preventing their separation. Moreover, the sub-serous, cellular tissue, which lies upon the iliac vessels in their entire course, becomes dense and firm near their exit, as it is being reflected from them to the anterior wall of the abdomen.

341. It may here be observed that the term *crural arch*, is applied to the whole space between the anterior superior spine of the ileum and the pubis, its boundaries being the irregularly curved border of the os innominatum, and Poupart's ligament, which stretches across it. Through this space pass the psoas and iliacus muscles, the crural nerve, and femoral vessels, which, with the peculiar arrangement of the membranes above described, effectually prevent the protrusion of a hernia between the spine of the ileum and the femoral vein. But such an occurrence may happen to the inside of that vessel, the intestine passing into the crural ring, whose boundaries (bearing in mind that it is lined by the membranous tube above described) may be thus enumerated: anteriorly it is bounded by Poupart's ligament, posteriorly by the os pubis, internally by the base of Gimbernat's ligament, and externally by the femoral vein. This ring forms the inlet to a canal whose outlet is the saphenous opening in the fascia lata, and through which the intestine descends, behind Poupart's ligament, into the upper part of the thigh, constituting *crural* or *femoral hernia*. The ring does not at first distinctly appear, even after the removal of the peritonæum, as its margin is still obscured by a layer of the sub-serous, cellular tissue, which in this situation, is rather thick and dense; this, however, can be readily removed. The relation of the vessels to the ring, requires to be attentively considered. The external iliac vein and artery lie to the outside of the ring, and

therefore of a hernial sack should it occupy that situation. The epigastric artery, arising from the iliac, runs obliquely along the external border of the crural ring, and must bear the same relation to a hernial tumour. Continuing to ascend, this vessel lies to the inner side of the spermatic artery and vas deferens, and, therefore, will be similarly placed with regard to the neck of an oblique, inguinal hernia. When the obturator artery arises from the epigastric, which is not an unusual occurrence, it passes downwards and inwards into the pelvis. If it arises by a common trunk with the epigastric, or starts from that vessel close to its commencement, its course, as it descends, will lie obliquely along the lower half of the external border of the ring. In such a case that aperture, if viewed from within, the vessels having been injected, will present the form of an ellipse, its greater diameter being from before backwards, the external side being formed by the two arteries diverging to their destinations, and the internal one by the curved base of Gimbernat's ligament. But should the obturator artery arise from the epigastric higher up, its direction will then correspond with the superior and inner border of the ring, which will therefore be nearly surrounded by vessels. This, however, is a very rare occurrence.

342. Having thus examined the disposition and mutual relations of the different structures of which the abdominal parietes are composed, we proceed to make a few remarks on the practical application that may be made of the facts, which we have here reviewed in detail. We shall suppose that the subject lies on the table, and that the different processes of dissection above pointed out, have been conducted on one side, the other remaining untouched. It may in the first place be observed, that if a hernial tumour has occurred towards the lower part of the abdomen, the intestine must have escaped either immediately above Poupart's ligament, or below it. In the former case it is termed inguinal hernia, in the latter crural. It must obviously be a

matter of the first consequence to determine this point with certainty, and without any delay; for on it depends, not only the success of the efforts made to reduce the hernia, by what is called the taxis, but also the propriety and manner of performing every step of the operation requisite for the relief of a strangulated intestine, from the first incision through the skin to its final completion. This question can be determined only by ascertaining with accuracy the position of the neck of the tumour, and then carefully tracing out its relation of place, or its position with regard to Poupart's ligament. If the tumour be of moderate size, so that the finger may be passed along the ligament, from the tuberosity of the pubis outwards, little doubt can remain as to whether it lies below or above its border. But a large inguinal hernia will obscure this part, by its descent, and a large crural one by its ascent; for when the latter has passed down for some way, it turns up towards the abdomen, lying on Poupart's ligament, and so occupies the situation of the other species. But if such a tumour can be drawn down a little, by making it slide between the skin and fascia, its point of exit can at once be determined. And if, in the other form of the disease, the tumour be pushed a little upwards and inwards, so that the situation of its neck can be ascertained, and the ligament defined, as above suggested, a satisfactory conclusion will at once be arrived at. Suppose it to be decided that the tumour lies above Poupart's ligament, and therefore, that it is an inguinal hernia, we have seen that its descent may be along the course of the inguinal canal, or it may pass straight forwards through the external ring, constituting, in the former case, an oblique, in the latter, a direct inguinal hernia. It is indispensably necessary, as well in reference to the taxis, as to the operation, to distinguish even these, though so closely allied. The situation of the spermatic cord, the direction of the tumour, and also its form, furnish sufficient data on which the diagnosis may be established. In the oblique form, the tumour inclines upwards and outwards, in the direction of the spine of the ileum, the vas deferens and the spermatic vessels lying behind it. In the direct descent, the tumour may be traced upwards in the direction of the umbilicus, and the cord will be found to its external side, and partly in front of it.

343. Now, if the previous question here raised be determined, and if the case has been decided to be an oblique inguinal hernia, it remains for the surgeon to restore the intestine, by the taxis, if possible; if not, by an operation. Previously to making any effort at reduction, the abdominal muscles should be relaxed as much as possible, which can be done by approximating their points of attachment. With this view, the body being placed in the recumbent posture, the shoulders should be raised and supported, and the thighs bent on the pelvis, that of the affected side being also inclined a little inwards, to lessen the tension exerted on Poupart's ligament by the iliac portion of the fascia lata. So far, a knowledge of the anatomical connexion of the parts points out the propriety of placing the body and the limbs in a particular position, rather than in any other. In the next place, the tumour being taken hold of steadily with one hand, and elevated somewhat towards the ring, compression should be made on its neck with the two first fingers and thumb of the other, followed by an effort to push it upwards and outwards, that is to say, in the direction of the inguinal canal. These measures should be employed until hopes of success fail, or until it is no longer safe to continue them, from their tendency to excite or increase inflammation, in parts placed under circumstances which dispose them to run very speedily into that condition. When all efforts at reduction prove fruitless, the operation must necessarily be resorted to, and the sooner it is done the better. When placed on the operation table, the shoulders should be raised in the same way as whilst the taxis was being performed, but the legs must be allowed to

hang over the margin of the table. In the first place, the skin may be made tense over the tumour, by straining it between the fore-finger and thumb of the left hand, if the tumour be small, or if it be large, by supporting it in the palm of the hand, and drawing the skin from behind. The integument may then be divided by an incision drawn over the convexity of the tumour, beginning at its upper extremity, or even a little above it, and continued down to the lower, unless it be very large. Another mode of making the first incision is by pinching up the skin into a fold, running transversely with regard to the tumour, and dividing it down to its base, or point of reflexion. When this is done, and the skin is allowed to return to its original position, the line of the incision through it will be found to correspond with the direction of the tumour. This incision will divide the skin and superficial fascia, and also a small vessel, which sometimes requires to be secured, viz., the superficial, or external pudic artery. The fascia of the cord becomes by these means exposed, a small piece of which should be pinched up between the blades of the forceps, and cut off close to their points, so as to make an aperture barely sufficient to admit the director. The instrument being passed upwards to the ring, the fascia is to be divided upon it by running the scalpel along its groove, and then downwards to the extent of the external incision. The cremaster is thus brought into view, and is to be divided with equal caution, and after the same manner. The hernial sack, however, is not yet laid bare, it remains covered by what we have already alluded to as the sub-serous cellular tissue, and by the thin prolongation given off from the margin of the internal ring, and which, as it descends, gradually degenerates into cellular tissue. This "must be cautiously cut through," by employing the forceps, director, and scalpel, as above stated, and so the peritonæal investment, or the proper hernial sack is exposed; to open which requires "the utmost caution." The operator should "nip up a small portion of the membrane, over the inferior and anterior part of the tumour, between the fore-finger and thumb of his left hand, and then, by gently rolling it between them, he easily distinguishes if any intestine be included; if so, he raises a fresh portion."* The slight rotatory motion of the fingers here directed will in most cases suffice to insulate the membrane from the intestine; and when this is done, the fold compressed between the fingers may be divided by the scalpel, or by the scissars, so as to make a small opening for the admission of the director. Whilst the director is being introduced and passed up towards the ring, its grooved border should be carefully kept in close apposition with the inner surface of the sack, lest by any means a part of the intestine should insinuate itself between them, and be divided, as the scalpel runs along the groove. It now only remains, so far as the operative part is concerned, to ascertain the seat of the stricture, and to divide it. For this purpose the fore-finger of the left hand is passed into the hernial sack, to the point at which it becomes constricted, which will be found in one or other of the three following situations, and may be stated in the order of their frequency as follows: 1. At the internal ring, in the mouth of the sack: 2. In the canal itself, about an inch or a little more within the external ring, the compression being formed by the lower border of the internal oblique and transversalis muscles, where they arch over the neck of the tumour: 3. At the external ring, which is much less frequent than the others. The finger having reached the strictured part, a probe-pointed bistoury is to be passed along it, its side resting on the palmar surface of the finger; and when it has been conducted beneath the stricture, the edge should be turned forwards, "so that the division of the stricture should be made in a direction parallel with the line alba, that is to say, directly upwards." In performing this part of the operation, the only thing to be apprehended is the division of the epigastric artery. It will be recollected that this vessel lies to the inside of the neck of the tumour, in cases of oblique inguinal hernia, and, on the outside, in the direct hernia. If the diagnosis, in a given case, were so clear as to leave no room for doubting whether the descent was oblique or direct, the position of the artery would at once be determined with regard to the neck of the tumour, and the direction in which the stricture should be divided may be indicated with certainty. In the oblique form, the artery may be effectually avoided by cutting outwards;—in the direct, by inclining the incision inwards; and in recent cases doubts seldom arise on the question. But when a hernia has been of long standing, the weight of the tumour, by drawing on its neck, and therefore on the internal ring, approximates it to the external one, by which means it occupies the situation of a direct hernia. If on examination such a case were pronounced to be a direct descent, and if, on such an assumption, the incision were made inwards, the artery must be divided. Such an occurrence can only be avoided by adopting the precept laid down by Sir Astley Cooper, viz. of cutting upwards in all cases of inguinal hernia, whether they be direct or oblique.

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* Sir Astley Cooper's *Lectures*, edited by F. Tyrrell.

344. In cases of direct inguinal hernia, the coverings of the sack are the skin and superficial fascia, the fascia of the cord, the conjoined fibres of the internal oblique and transversalis (if they be not ruptured), together with the fascia transversalis. The cremaster muscle forms only a partial covering, near the external ring, for there the cord and the tumour come into contact; but they instantly diverge, one passing upwards into the abdomen, the other outwards in the course of the canal. The division of the different structures above enumerated is to be conducted on the same principle as in the oblique descent, but with a degree of caution the more, as the tumour has a covering the less.

345. When a portion of intestine passes into the crural ring it necessarily pushes before it that part of the perito-

næum which lines the aperture, and, thus invested, descends into the tubular prolongation sent down, round the femoral vessels, from the membranous lining of the abdomen. After descending for about an inch and a half, its progress downwards is arrested; and if the quantity of intestine protruded increases, the tumour turns forwards through the saphenous opening, in the fascia lata.. There its direction becomes altered again, as it is made to ascend obliquely inwards, lying in front of the iliac portion of the fascia lata (its falciform process), and even of Poupart's ligament; so that it forms, by its different turns, a curve whose concavity looks upwards.

Having thus described the progress of the intestine, we are prompted to inquire what are the circumstances in the structure of the parts through which it passes, which determine these changes in its direction. Having descended to the point above indicated, the tumour is checked by the narrowing of the tube in which it is enclosed. This, though wide above, where its inner border is separated at a considerable interval from the femoral vessels, gradually contracts so as to come into close contact with them; and where it does so it must become intimately connected with them by the *vasa vasorum*. The lower border of the saphenous opening is also closely applied to the sheath of the vessels in this situation; and as the pubic portion of the fascia lata passes behind, whilst the iliac arches in front of it, any extraneous substance that may pass down in the sheath would be constricted by that arrangement of the fascia, even if the connexion between the vessels and the sheath were not sufficient to produce such an effect. These causes limit the descent of the intestine, and determine its passage forwards through the saphenous opening, where comparatively little resistance is given. But, it will be asked, why does the hernia turn upwards? why does it not rather descend in front of the thigh, lying between the skin and the fascia lata? more especially as, from its exit out of the abdomen, down to its first turn, it had been lying on the pubic portion of that fascia? The impediment to its descent in that way is produced, partly by the manner in which the superficial fascia is connected to the margin of the saphenous opening, but chiefly by the superficial epigastric vessels which run on its surface. With these the tumour comes into contact, after emerging through the opening, and, though by the firmness of their connexion with the deep vessels, they resist its descent, they offer no obstacle to its ascent, so that during this part of its course it necessarily passes up between the superficial vessels and fascia, which lie in front of it, and the fascia lata lying behind.

346. To restore to its natural situation an intestine so placed, it becomes necessary to make it retrace its steps as it were, describing successively, but in a retrograde course, the different turns it had made in its passage. With this view, after having adjusted the body so as to relax the abdominal muscles, and to take off all tension from Poupart's ligament, the patient being placed with the affected side close to the side of his bed, the surgeon draws the tumour downwards into the hollow at the upper part of the thigh, so as to bring it opposite the saphenous opening. This being done, it should be pressed backwards, as if into that aperture, and upwards, with a slight inclination outwards, so as to avoid any impediment that may be presented by Gimbernat's ligament. Should these, and the other usual expedients fail, the operation must be resorted to, even still more speedily than in cases of inguinal hernia. When commencing the operation, the first step (after the body has been properly placed) consists in dividing the skin by a transverse incision carried over the middle of the tumour from one side to the other, parallel with Poupart's ligament, and of course below it. This incision may be made by pinching the skin into a fold parallel with the femoral vessels, and cutting down to its base, after which, when allowed to return to its natural situation, it will be found di-

vided in the extent and direction above indicated. This should be met at right angles by another incision, begun about an inch and half above the crural arch, so that both together shall resemble an inverted *L*. Many surgeons, it may be observed, commence with a crural incision. Dupuytren usually does so. Sabatier discountenanced the practice, through a fear, that if the vertical incision were carried below the horizontal one, so as to form a cross, the saphena vein might be wounded. If the tumour be very small, such an accident may arise from prolonging the incision below the middle part of it; but when it increases, and comes forwards through the saphenous opening, it lies on a plane anterior to the vein, which therefore is out of all danger. In the transverse incision, through the skin, the superficial epigastric artery is divided, but that is of little consequence. The angular flaps of integument having been reflected, the superficial fascia becomes exposed, and should be divided to the same extent. It is much thicker than where it forms a covering for inguinal hernia, and contains, moreover, some of the superficial lymphatic glands. The funnel-shaped investment of the femoral vessels, or *fascia propria*, next comes into view, which is to be cautiously divided by pinching up a small piece between the blades of the forceps, and cutting it off close to their points, thus making an aperture sufficient to admit a director. When the fascia propria is divided the hernial sack is, in most cases, still obscured by that thick lamella of cellular tissue, which lies across the crural ring, and has been pushed down before the peritonæum, as the hernia descends. It is scarcely necessary to add, that this also must be divided, after which, whilst the proper sack, or peritonæal covering of the intestine is being opened, the same precautions should be observed, that have been already suggested when describing the operation for inguinal hernia. When the contents of the sack are exposed, the operator has to divide the stricture, which obviously includes a consideration of the place at which the division should be made, and the manner of making it. The finger being introduced into the sack, and passed upwards along its anterior and inner side, for the purpose of ascertaining the seat of the stricture, it will be found, according to the testimony of our highest authorities, either at the arched border of the saphenous opening, at the edge of Poupart's ligament, or in the neck of the hernial sack. Should a stricture be found at the border of the opening in the fascia lata, a bistoury may be introduced on the finger, and its division effected by directing the edge of the instrument obliquely upwards and inwards. This part can be the seat of stricture only when the tumour is sufficiently large to turn forwards and upwards, and it not unfrequently happens, that though it be divided, still the reduction of the intestine cannot be effected. Another stricture must then exist higher up, in one or other of the situations above indicated, to remove which different modes of proceeding have been recommended, all however, having a common object, viz., to widen the opening through which the intestine had escaped in the first instance, and which it necessarily must repass whilst it is being restored. The superior boundary of the crural ring, being Poupart's ligament, the internal one that of Gimbernat, the proposed end must be attained by the division of one or other. Sir Astley Cooper is of opinion that Gimbernat's ligament cannot be the seat of stricture; for, "if strangulated femoral hernia be examined in the dead body, and that ligament cut through, the hernia is not liberated by such a division." If it be on these grounds concluded that the stricture is situated at the border of Poupart's ligament, or in the neck of the sack, the same incision will necessarily divide both. But in what direction should it be made? This question must be determined by a reference to the position of the vessels, or parts, which lie contiguous to the margin of the ring. If the incision were directed upwards, in a male subject, the spermatic vessels and vas deferens must be wounded, should it be carried beyond a very few lines. In the female the round ligament only would be endangered, which is of comparatively little consequence. To avoid these consequences, Sharpe recommended the edge of the bistoury to be inclined upwards and outwards, by which means its direction would be parallel with that of the cord; but then the epigastric artery lies exactly before it. Though this fact would seem rather decisive against adopting the practice, Dupuytren prefers it to any other, and no vessel appears to have been wounded in any of his operations; doubtless, from the fact that it is only necessary to divide a few fibres of the ligament. One point then remains, in which the stricture may be divided without risk, viz. by inclining the edge of the bistoury, after it has been introduced, obliquely *upwards and inwards.* On this but one contingency rests, and that an extremely remote one, namely, when the obturator artery rises from the epigastric in such a way that, as it descends into the pelvis, it runs along the anterior and inner side of the ring. For full information on this important subject the reader will consult the following works:—SIR ASTLEY COOPER'S *Treatise on the Anatomy and Surgical Treatment of Hernia:* LAWRENCE *on Ruptures:* SIR A. COOPER'S *Lectures on Surgery,* edited by F. TYRRELL: and SCARPA *on Hernia.*

CHAPTER V.

THE MUSCLES OF THE BACK.

347. The muscles placed along the posterior part of the trunk are found to be arranged in layers, or strata, placed one over the other, and differing materially in extent, attachments, and use. The superficial muscles are so broad as to cover all the others; and as their extent is considerable, their number is proportionally diminished, being only two, viz. the trapezius and latissimus dorsi. The second set may be said to consist of the rhomboïdei, levator anguli scapulæ, the splenii, and serrati postici. In strictness, the two first form a layer by themselves, and so do the two last; but it would tend to no useful purpose to multiply these sub-divisions. In the third set are included the erector spinæ, consisting of the sacro-lumbalis, and longissimus dorsi, with their cervical prolongations, viz. the cervicalis descendens, transversalis colli, and trachelo-mastoïdeus; lastly the complexus. The fourth layer comprises the spinalis muscle, consisting of two parts, viz., the spinalis colli and spinalis dorsi, the multifidus spinæ, the inter-spinales, intertransversales, and, finally, the small muscles placed between the base of the skull and the two first vertebræ, viz., the recti postici and obliqui.

348. The *trapezius* (*cucullaris*, Soëmm.; *occipito-dorsi-sus-acromien*, Dumas) extends along the posterior part of the neck, as well as of the back and shoulder. If the two muscles of this name be taken together, they represent a four-sided figure (whence the name) two angles of which correspond with the points of the shoulders, one with the occipital protuberance, and the fourth with the spinous process of the last dorsal vertebra. The trapezius *arises*, 1, from the occipital protuberance, and from about a third of the oblique

ridge, extending forwards from it; 2, in the cervical region, from the fibres of the corresponding muscle, both being blended together, and from a tendinous band, called *ligamentum nuchæ*; 3, from the spinal process of the last cervical, and all those of the dorsal vertebræ, as well as from the inter-spinous ligaments. From these different points of origin the fibres proceed towards the top of the shoulder, following very different directions; those from the occiput inclining downwards and outwards, and those from the lower part of the back upwards and outwards, the obliquity of each set diminishing, so that those intermediate between the two extremes become horizontal. The superior fibres turn forwards a little, and are inserted into the external third of the clavicle, the middle pass transversely to the upper border of the acromion process, whilst the inferior ones ascend to that of the spine, being attached as far back as the triangular surface at which it commences. The tendinous fibres by which the muscle arises are rather short along the interval from the last dorsal vertebra as high as the fourth; there they lengthen gradually, but opposite the fourth cervical vertebra they again acquire about the same extent, so that in the interval between these points, the union of the muscular with the tendinous fibres forms a crescent, and if the two muscles be dissected together they will represent an oval.

From the line of union of the two trapezii along the neck, a band of condensed cellular membrane, mixed with tendinous fibres, extends deeply, so as to reach the spinous processes of the vertebræ, forming a septum between the sets of muscles on each side of the middle line. It is attached by one extremity to the occipital protuberance, by the other to the spinous process of the seventh cervical vertebra; its posterior border being blended with the fibres of the trapezii, whilst the anterior is fixed to the spinous processes. This is usually called *ligamentum nuchæ*. In the human subject it can only be considered as a rudiment of that peculiar elastic band which serves to sustain the weight of the head in the lower animals. *Structure*—the trapezius is fleshy in the greater part of its extent, and tendinous at its attachments: *relations*—by its posterior surface with the skin, beneath which it lies in its entire extent; the anterior one covers part of the complexus, the splenii, levator anguli scapulæ, the supra-spinatus, infra-spinatus slightly, the rhomboïdei, and part of the latissimus dorsi. Where the inferior fibres slide over the triangular surface between the base and spine of the scapula, in order to reach the upper border of the latter, a synovial bursa is interposed.

349. The *latissimus dorsi* (*dorsi-lumbo-sacro-humeral*, Dumas) occupies the whole of the posterior part of the lumbar region, and the lower half of the dorsal. Its form is triangular. It arises, 1, from the spinous processes usually of the six lower dorsal vertebræ, from all those of the lumbar region and of the sacrum; 2, from the external border of the crista ilei (its posterior third); 3, by fleshy digitations from the three or four last ribs, where they are interposed between similar processes of the obliquus externus. The tendinous fibres from the two first lines of origin, form by their inter-texture, or union, a broad aponeurosis, from which the fleshy fibres proceed, converging towards the axilla. Those from the dorsal vertebræ pass almost horizontally outwards, and all the rest with increasing degrees of obliquity, so that those from the ribs ascend almost vertically. By this convergence, the fibres form a narrow and thick fasciculus, which slides over the inferior angle of the scapula, from which it sometimes receives a small accessory muscle. In this situation it rests on the teres major, which it accompanies towards the axilla, but gradually turns, as it were, on itself, so as to get to the anterior aspect of that muscle, and is inserted into the posterior border of the bicipital groove in the humerus. The flat tendon by which the latissimus dorsi is inserted becomes united, particularly by its lower border,

with that of the teres; it ascends higher than the latter, and also lies nearer to the brachial vessels. It is sometimes connected to the pectoralis major, by a fleshy fasciculus extended across the axillary space. *Structure*—aponeurotic in the lumbar region, tendinous at its insertion, fleshy in the rest of its extent: *relations*—it is covered by the trapezius at its dorsal origin, and subcutaneous in the rest of its extent, except where it ascends into the axilla. The anterior surface rests on the deep lumbar muscles, the serratus posticus inferior, part of the obliquus internus abdominis, and serratus major, the rhomboïdeus major, infra-spinatus, and teres major; its internal border is blended with the fibres of the corresponding muscle, along the middle line, the inferior intermixes with those of the gluteus maximus. The superior is free, and describes a slight curve, whose concavity looks upwards; the anterior one, also free in the greater part of its extent, slightly overlaps the obliquus externus below, and higher up the serratus magnus.

Combined Actions.—The trapezius and latissimus dorsi direct or influence the motion of several parts, as must be evident from the extent of their attachments. If the shoulders be fixed, the trapezii muscles acting together, draw the head directly backwards; but if only one of them acts, it inclines the head to the corresponding side. If the head be fixed, the superior part of the trapezius elevates the point of the shoulder, and sustains it in that position, as when a burthen is supported upon it; but, if the effort required be considerable, or if it must be continued for any length of time, the co-operation of the serratus magnus becomes indispensable. It would appear at first sight, from a mere inspection of the fibres of this muscle, that those in the middle part of it could draw the scapula directly backwards, and the lower ones draw it downwards. This, however, is far from being the fact. As the muscle is attached to the spine of the scapula and the acromion, it will rather, in consequence of the obliquity of the direction of these processes, communicate a certain degree of rotatory motion to the whole bone, by means of which, when the acromion ascends, the posterior angle descends, and the inferior one comes forward;

and should the acromion be made to resume its previous position, the inferior angle will move backwards, the superior one upwards. The bone then, in its movements, cannot be made to ascend or descend, to go backwards or forwards, in such a way that the direction of its different parts may remain exactly parallel, in their new situations, to those which they had previously occupied. The bone will, on the contrary, be found to rotate, as it were, on a pivot driven through the centre of its dorsum. To draw the scapula directly backwards requires the combined effort of the trapezius and rhomboïd muscles; for, as their fibres decussate, the direction of the one being obliquely downwards, that of the other upwards, the bone, by their combined action, is made to move in the direction of the diagonal of their forces, that is to say, towards the spinal column.

The latissimus dorsi, acting on the shaft of the humerus, necessarily draws it downwards, and gives it at the same time a rotatory motion on its own axis, particularly if it had been previously everted, or turned outwards. When the shoulder and arm are rendered fixed, the muscle acts in various ways on the trunk. Thus it assists in forcible inspiration, by drawing on the lower ribs and elevating them. By conspiring with the abdominal and greater pectoral muscles, it elevates and sustains the body in the effort of climbing; and when an individual is constrained to resort to the assistance of crutches, the latissimus and pectoralis major are the chief agents in progression. The arms are in the first instance fixed by grasping the long handle of each crutch; and as the muscles, which form the borders of the axilla are thus made to rest on the cross bar of the crutch, they derive thereby all the mechanical advantage of sliding over a pulley-like surface. Thus adjusted, when the muscles contract, they necessarily draw the body up towards the fulcrum, over which they pass, and so enable the other moving powers to propel the body and limbs forwards.

The trapezius and latissimus dorsi, more particularly the latter, can act under certain circumstances on the spine, preparatory to which the shoulder and arm must become (at least relatively) the fixed points of their attachment. When a man walks close to the margin of a raised foot-path, or of a curb-stone, and happens to incline a little beyond it, the body becomes curved to that side, and by its own weight would carry him over it, if a particular effort were not made to prevent such an occurrence. For this purpose the arm of the opposite side is, as it were, instinctively thrown out somewhat from the body, so as to render the insertion of the latissimus dorsi into that bone, its fixed point of attachment. Thus sustained, the fibres of the muscle are enabled to act on the spine, and by pulling on those parts of it which are curved, they draw them into a right line with the rest, and so restore the equilibrium of the body. An individual walking on a rope is always observed to keep both arms fixed, and removed a little from the sides; this is obviously for the purpose of bringing the latissimus of each side into action, in order to rectify the curvatures which alternately occur, now to one side, now to another. In order to give greater effect to the power of the muscles, such persons carry a pole, which is held transversely. When the body deviates to one side, the opposite arm is at once completely fixed, by grasping the pole firmly with the hand, and so the muscles are enabled to act on the spine with increased effect, and restore it to the perpendicular position.

350. The *rhomboïdeus* (*cervici-dorso-scapulaire*, Dumas) is usually divided into two muscles, which, though they lie on the same plane, are similar in structure and use, and differ only in size. The two parts of the muscle are separated by a slight cellular interval. It is extended obliquely from the spinous processes of the lower cervical and upper dorsal vertebræ, to the base of the scapula. 1. The *rhomboïdeus minor arises* from the spinous process of the seventh cervical vertebra, and from the ligamentum nuchæ, its fibres being also closely united with those of the trapezius. It inclines downwards and outwards, to be inserted into that part of the base of the scapula that corresponds with the triangular surface from which the spine commences. 2. The *rhomboïdeus major*, three or four times broader than the other, is placed in close contact, and immediately below it. It *arises* from the spinous processes of the four or five upper dorsal vertebræ, and is inserted into that part of the base of the scapula included between its spine and inferior angle. *Direction*—downwards and outwards: *structure*—

muscular in the greater part of its extent, tendinous at its orgin: *relations*—it is covered by the trapezius in the greater part of its extent, and towards the lower part by the latissimus dorsi; but when the arm is drawn away from the side, a small portion is left uncovered by these muscles, where they diverge at the base of the scapula.

351. The *levator anguli scapulæ* (*trachelo-anguli-scapulaire*) is placed along the side and posterior part of the neck, forming a long and rather thick fasciculus of fleshy fibres. It *arises* from the posterior tubercles of the three or four superior cervical vertebræ, by so many tendinous points. From these the fleshy fibres proceed, being at first slightly separated, but soon united to form a flat muscle, which is inserted into that part of the base of the scapula, included between its spine and superior angle. *Direction*—downwards and a little backwards: *structure*—fleshy in the greater part of its extent, tendinous at its origin: *relations*—it is covered by the sterno-mastoïd muscle above, and by the trapezius below; it rests on the splenius colli, transversus cervicis, and serratus posticus superior.

352. The *serratus posticus superior* (*cervici-costo-dorsal*) is placed under cover of the rhomboïdeus; it is flat, and exceedingly thin. It *arises* from the spinous process of the last cervical, and from those of two or three upper dorsal vertebræ, by a thin aponeurosis, which inclines downwards and outwards, soon becoming muscular, and is inserted by four fleshy digitations into the bodies of the second, third, fourth, and fifth ribs, a little beyond their angles. Its direction is obliquely downwards and outwards, resting on the deep muscles and angles of the ribs.

353. The *serratus posticus inferior* (*dorsi-lumbo-costal*) is broader than the preceding muscle, from which it is separated by a considerable interval, the one corresponding with the upper, the other with the lower ribs. It *arises* from the spinous processes and inter-spinous ligaments of the two last dorsal, and two or three first lumbar vertebræ, by

a thin aponeurosis. This ends in a fleshy lamella, which is inserted by four digitations into the bodies of the four last ribs, a little beyond their angles. Its *direction* is upwards and outwards: *structure*—partly muscular, partly aponeurotic: *relations*—its posterior surface is covered by the latissimus dorsi, the anterior rests on the deep lumbar muscles.

354. On the same plane with the serrati, and connecting their borders, may be observed a thin, semi-transparent lamella, which forms a septum between the superficial and deep muscles. Its fibres are for the most part transverse, being extended between the spinous processes of the vertebræ and the angles of the ribs. Some anatomists have named it the *vertebral aponeurosis*, and conceive it to be intended for the purpose of binding down the extensor muscles of the spine.

355. The *splenius* muscle is placed obliquely along the posterior part of the neck; it is usually divided into two parts, one being extended from the spinous processes of the upper dorsal and lower cervical vertebræ, to the side of the base of the skull, the other to some of the contiguous transverse processes. This separation of the muscle at its superior attachment has given occasion for its division into two parts, the lower being named splenius colli, the upper splenius capitis. *a.* The *splenius colli* (*dorso-trachelien*) arises from the spinous processes of four dorsal vertebræ, from the third to the sixth inclusive: the fibres ascend, forming a flat, muscular plane, which is inserted by separate points into the transverse processes of the three or four superior cervical vertebræ, close to the origin of the levator anguli scapulæ. *b.* The *splenius capitis* (*cervico-mastoïdien*) not only differs from the preceding in situation, being placed superior and internal to it, but is also somewhat broader and thicker. It arises from the spinous processes of the three or four lower cervical, and of the two superior dorsal vertebræ, from which its fibres proceed

upwards and outwards, to be inserted into the external part of the mastoïd process, and also into part of that rough surface on the occipital bone, which is included between its curved lines. *Direction*—obliquely upwards and outwards; *structure*—tendinous at its attachments, fleshy in the rest of its extent: *relations*—its posterior and external surface is covered by the trapezius, sterno-mastoïd, and levator anguli scapulæ; the other rests on the complexus, trachelo-mastoïd, and longissimus dorsi.

Combined actions.—The levator anguli scapulæ conspires with the rhomboïdeus in one of its more obvious actions. When the acromion process is elevated, the posterior angle of the scapula is depressed, and the inferior one carried forwards; but as soon as the more powerful muscles cease to act, the levator draws upwards the posterior angle of the bone, whilst the rhomboïd carries backwards and upwards the inferior angle, thus giving a slight rotatory motion to the whole bone, and at the same time depressing the acromion and point of the shoulder. If the shoulder be fixed, the levator may incline the neck down to the same side, just as the trapezius draws the head under the like circumstances. If the rhomboïd muscle conspires with the middle and lower part of the trapezius, the base of the scapula will, by their joint effort, be carried directly towards the spine.

The serrati postici, in their action on the thorax, (which from their size is necessarily insignificant) are antagonists. The inferior one is enabled by the direction of its fibres to depress the ribs, and to assist in expiration; but the other elevates the ribs, into which it is inserted. Both, however, are considered to possess the power of rendering tense the vertebral aponeurosis which intervenes between them.

If the splenii muscles of both sides act together, they draw the head directly backwards, in which they conspire with the complexus and trapezius. When those of one side act separately, they incline the head laterally, giving it at the same time a slight rotatory motion. The complexus, too, by reason of the oblique direction of its fibres, can give a certain degree of horizontal motion to the head, but in a direction contrary to that of the splenii, as must be evident from the fact, that the fibres of the one incline outwards as they ascend, and those of the other inwards.

356. The term *erector spinæ* may with much propriety be applied to that long, intricate interlacement of muscular fibres, which in the lumbar region forms a thick mass that fills up the vertebral groove, but which along the back becomes divided into two parts, viz. the sacro-lumbalis and longissimus dorsi. The muscle arises, 1, from the spinous and transverse processes of the four inferior lumbar vertebræ; 2, from all the spines of the sacrum, as well as its lateral parts; 3, from the sacro-iliac ligaments, and from the posterior third of the crista ilei. At its origin from the sacrum, it is tendinous; where it corresponds with the loins, the external half is fleshy, the internal aponeurotic. Opposite the last rib, the muscle becomes separated into the parts, above mentioned, by a cellular interval.

357. 1. The *sacro-lumbalis*, or rather (if its attachments be considered) the *lumbo-costalis*, proceeds upwards, forming the exterior part of the erector spinæ, inclining a little outwards as it ascends, at the same time becoming narrower, inasmuch as it deposits, as it were, upon each rib part of its fibres. These end in tendinous processes, which are inserted into the angles of the six or seven lower ribs, and so the muscle (at least the part of it that can be traced up from the lumbar region) should be considered as terminating, but that a series of accessory fibres begin to be placed along its inner side, by which it is prolonged to the neck. These bundles of fibres, which are overlapped by the insertions of the muscle itself, commence at the angles of the ribs by tendinous points, that soon become fleshy, and pass up over one or two intercostal spaces, to be inserted successively into the angles of the superior ribs, and so the chain of continuity is maintained along the thorax. Intimately united with these may be observed another and larger fasciculus of fibres, by which the muscle is prolonged

into the neck, and which on that account was formerly named *musculus accessorius ad sacro-lumbalem*, but has more recently been called cervicalis ascendens, from its resembling a process sent up into the neck from the sacro-lumbalis, whilst others have applied to it the term cervicalis descendens, from the circumstance that its more fixed point of attachment is at the transverse processes of the cervical vertebræ, from which it passes down along the angles of the ribs, and intermingles with the fibres of the sacro-lumbalis. The cervical prolongation of the sacro-lumbalis (*cervicalis ascendens; cervicalis descendens—musculus accessorius*) *arises* from the angle of the sixth, fifth, fourth, and third ribs, by a series of tendinous fasciculi, which are blended with the fibres of the sacro-lumbalis. These gradually unite to form a thin, short, muscular band, which extends along the transverse processes of the sixth, fifth, fourth, and third cervical vertebræ, into which it is inserted by so many separate digitations or points.

358. 2. The *longissimus dorsi*, or inner division of the erector spinæ, is prolonged vertically upwards from the lumbar mass, gradually diminishing in size as it ascends. It lies in the middle of the vertebral groove, intermediate between the sacro-lumbalis and the semi-spinalis dorsi, from which it is separated by deep cellular intervals. The posterior surface is smooth and even, but from the anterior a number of processes are sent off, which are inserted into the transverse processes of the dorsal vertebræ, as well as the adjacent rough surface of the ribs. Considerable variety occurs in the number of these attachments to the ribs; sometimes they can be traced to only seven or eight, at others to eleven. The muscle would at first sight appear to cease at the top of the thorax; but when examined in that situation, it will be found connected intimately with two muscular fasciculi, which may be considered as accessories to it. By one of these it is prolonged into the neck, and connected with the transverse processes of the cervical

vertebræ, by the other with the mastoïd process and the base of the skull. *a.* The ***transversalis colli*** (***transversus cervicis***, Soemm.) ***arises*** from the transverse processes of the four or five upper dorsal vertebræ, by so many separate points, which are connected with the fibres of the longissimus dorsi: these form a flat, irregular fasciculus, which is prolonged upon the transverse processes of the cervical vertebræ, and inserted by a series of tendinous and fleshy points into their posterior tubercles, from the sixth to the second inclusive. The muscle must, from its mode of origin and insertion, be thinner towards its extremities than in the middle. Its external side is in contact with the cervicalis descendens and splenius colli, which rest upon it; the internal one lies on the complexus and trachelo-mastoïdeus, being, in most instances, so closely united with the latter, that they are with difficulty separated. *b.* The cranial prolongation of the longissimus dorsi (***trachelo-mastoïdeus; complexus minor***) arises by a series of distinct fasciculi from the transverse processes of the three or four upper dorsal vertebræ, and the three lower cervical. The union of these forms a flat and thin muscle, which ascends inclining somewhat outwards, to be inserted into the posterior border and extremity of the mastoïd process. Its internal surface rests on the complexus for the greater part of its extent; farther up it crosses over the obliquus capitis (superior and inferior), and covers the origin of the digastricus.

359. The *complexus* (*dorsi-trachelo-occipital*) is a thick and rather broad muscle, situated somewhat obliquely upon the posterior part of the cervical region. Its name is derived from the peculiar manner in which tendinous and fleshy fibres are intermixed in its structure. It arises from the transverse and articulating processes of the four or five superior dorsal vertebræ, and from the transverse processes of the four inferior cervical, by a series of tendinous points. These are soon aggregated into a mass, which proceeds

obliquely upwards and inwards, converging to the corresponding muscle of the opposite side, and finally is inserted into the irregular surface between the oblique ridges on the occipital bone. At their origin the two muscles of this name are separated at a considerable interval, but at their insertions they are in close contact. Its posterior or external surface, which is inclined obliquely outwards, is in immediate contact superiorly for a short way with the trapezius, in the middle of the neck, the splenius is interposed between them, and lower down the trachelo-mastoïdeus. The anterior, or inner surface rests on the spinalis colli, and higher up on the rectus capitis major, and on the obliqui.

360. The *spinalis* muscle is so named from being situated close along the spinous processes of the vertebræ. It consists of two parts, one occupying the cervical, the other the dorsal region. *a.* The *spinalis colli* (*semi-spinalis colli*) arises by four or five fasciculi from the transverse processes of the four or five superior dorsal vertebræ. These having united, incline inwards as they ascend, and are inserted usually by four separate points into the spinous processes of the cervical vertebræ, from the fifth to the second inclusive. Its fibres at their origin are covered by those of the longissimus dorsi, and in the neck by the complexus: its inner surface rests on the termination of the spinalis dorsi, and higher up on the inter-spinales cervicis. *b.* The *spinalis dorsi* (*semi-spinalis dorsi*) is placed in a continuous line immediately beneath the preceding muscle, and intimately united with it. It arises from the transverse processes of the dorsal vertebræ, from the eleventh to the fifth inclusive, by so many distinct fasciculi. These, having united, pass upwards, and are inserted into the spinous processes of the four superior dorsal, and two lower cervical vertebræ. Its fibres, at their origin, are concealed by the longissimus dorsi, and at their insertion, for some way, by the spinalis

colli; in the interval they lie between the longissimus dorsi and the spinous processes of the vertebræ.

361. The *interspinales,* as their name implies, are short fasciculi of fleshy fibres, placed between the spinous processes of the contiguous pairs of vertebræ. They are well marked, and defined in the neck; in the lumbar region they are seldom distinct, and in the dorsal can scarcely be said to exist. As each passes from the upper border of a particular spinous process in the neck, to be inserted into that next above it, it must consist of two parts, one for each tubercle, inasmuch as the spinous processes in this region (except the first and last) are bifid at their extremities. Their points of attachment at once indicate their extent and relations.

362. In close contact with the inter-spinales, and placed along their posterior border, may be observed, in most instances, some thin bundles of fibres, which cannot be said to lie within the interval of the spinous processes. On the contrary they extend from the summit of one, to the next, or second next, above it. From this circumstance they have been called *supra-spinales,* and as they increase gradually from below upwards, being situated in the median line, they may be considered as analogous to the recti capitis postici.

363. The *inter-transversales* are placed between the transverse processes of the cervical vertebræ: they can seldom, if ever, be demonstrated in the dorsal or lumbar region. As the transverse processes of the vertebræ in the neck are bifid, the muscles disposed between each pair of them are arranged in two planes, one before the other, so that the cervical nerves at their exit from the vertebral column necessarily pass out between them.

364. The *multifidus spinæ* extends along the spinal column from the sacrum to the axis, filling up the deepest part of the groove between the transverse and spinous pro-

cesses. It is made up of bundles of fleshy and tendinous fibres, intermixed rather confusedly together. The direction of all is more or less oblique, but their length varies considerably, as they are found to reach from the transverse process of a particular vertebra to the spinous process of that immediately above it, and, in other instances, to those higher up by one or two spaces. Thus formed, the structure here described should be considered not as a single muscle, but rather as an aggregate of many, which conspire in their general action on the vertebral column, by reason of the separate influence which each can exert on individual pairs of vertebræ. The first of these fasciculi extends from the side of the sacrum to the spinous process of the fifth lumbar vertebra, the last from the transverse process of the third cervical vertebra to the spine of the axis. The muscle gradually diminishes in bulk as it ascends; its fibres are intimately blended with those of the spinalis (dorsi et cervicis).

Combined actions.—The sacro-lumbalis, longissimus dorsi, and multifidus spinæ, conspire in fixing the spinal column, and thereby maintaining the trunk erect. If they continue their effort, the body will be drawn somewhat backwards, as may be observed when a considerable weight is suspended from the neck, or in persons who have become excessively fat. In both these cases, the extensor muscles are required to make increased efforts to counterpoise the influence of the weight appended to the fore part of the body. As these muscles have to sustain the trunk in the sitting as well as in the standing posture, it might be supposed that they scarcely admitted of any relaxation, and therefore are kept almost constantly in action. But it does not appear necessary, except in making great efforts, that all of them should be in action at the same moment, and even the different parts of the same muscle must, in most cases, act successively. Thus the lower fibres of the multifidus spinæ pass from the sacrum to the lumbar spines, and materially assist the quadratus lumborum and other muscles in fixing the bodies of the lumbar vertebræ. These, or rather their transverse processes, become the fixed points, from which the succeeding parts of the multifidus act on the spines throughout the entire length of the column, so that a succession of efforts is propagated from below upwards by a sort of vermicular motion. When by such an arrangement the action of one set of fibres succeeds that of another, each will have its alternations of contraction and relaxation, as well as the fibres of those muscles in which the change is more perceptible. The sacro-lumbalis can draw down the lower ribs; and if the efforts be continued, this influence must speedily be propagated to the spinal column, which is thus bent towards the side by means of the intimate connexion between the heads of the ribs and the vertebræ. The longissimus dorsi conspires to produce the same effect. The spine admits, to a certain extent, of a rotatory movement. Thus the head may be carried round by a horizontal motion, until the chin comes nearly on a line with the point of the shoulder, after which the spine may be made to turn on its own axis, until the face shall have completed almost a semi-circle, from the point at which its first movement began. This is effected by that peculiar action of the multifidus spinæ above alluded to; but it is the muscle of the opposite side from that towards which the movement takes place, that produces the rotation, assisted by the obliquus externus abdominis.

The influence of the sacro-lumbalis in depressing the lower ribs must be evident from its mode of attachment to them. But its accessory muscle (cervicalis ascendens) by taking its fixed point at the cervical vertebræ, is enabled to draw up, and therefore elevate the ribs into which it is inserted.

On re-considering the remarks made on the actions of the latissimus dorsi and trapezius, more particularly the influence they exert, under certain circumstances, in rectifying lateral inclinations of the body, it appears advisable to guard the reader against an erroneous application that may be made of them in the management of curvatures of the spine arising from disease. Curvature of the spine may follow as a consequence of a pathological condition, 1, of the lung, or its investing membrane; 2, of the osseous parts of the spinal column, or their ligamentous connexions; 3, of debility and atrophy of the muscles. In the first case, the alteration in the spine arises from a change in the position of the ribs at one side, inducing a flatness of the chest, and a diminution of its capacity. And it must be obvious, from the intimate union that subsists between the ribs and the vertebræ, that any decided alteration in the one must materially influence the other. In his articles " sur le retrecissement de la poitrine à la suite des certaines pleurésies," Laënnec has, with his usual precision, traced out the series of changes that lead to this result. In the first place, when the pleura has become inflamed, an effusion is poured out upon its surface, which separates into two parts, similar in many particulars to those into which the blood is resolved on cooling. The one concretes into a lamella, investing, to a greater or less extent, the exterior of the lung, and also lining the inner surface of the thorax; the other is a serous fluid, effused into the cavity of the pleura, compressing the lung in a degree proportioned to its quantity, and thereby removing it from the ribs. In the ordinary run of cases, on the subsidence of the inflammation, the fluid is absorbed, the fibrinous lamella is converted into thin bands of adhesion, and the lung, unaltered in its texture, freely admits the air into its cells, and, by becoming distended as usual, is applied to the inner surface of the thorax, and supports it, all the parts resuming their natural position and relations. But if the inflammation had extended to the lung itself, so that its texture had become altered, and its cells obliterated, then, whilst the serous fluid is being absorbed, the air cannot enter into the lung so as to distend its cells, and so bring it into contact with the ribs. The natural consequence of such a state of things must be, that the ribs, when left without support from within, will be forced inwards by the pressure of the atmosphere, and the intercostal spaces proportionally narrowed, and the side compressed. Lastly, the vertebræ will be drawn down, by means of their connexion with the ribs, so that a permanent lateral curvature of the spine is established. In the next class of cases, the bodies of the vertebræ, having become attacked with caries, the column gradually bends forwards, and gibbosity is produced. But there are other instances, in which a softened condition of the bodies of the vertebræ occurs, with a corresponding alteration in the fibro-cartilages and ligaments. The column, no longer able to support the super-incumbent weight, inclines to one side, the bodies of the bones, as well as the inter-vertebral cartilages, are compressed along the corresponding lateral half, and their perpendicular depth diminished, by which means a curvature is established. Now suppose the concavity of the curve to look towards the left side, as is usually the case, we may, even with a slight degree of attention, follow the gradual steps by which the curve increases and becomes permanent. In the first place, in consequence of a natural or acquired disposition, the muscles of the left side are less frequently used than those of the right. When, as in the case here supposed, the frame-work of the body is bent to one side, the muscles become relaxed, and comparatively powerless; the process of nutrition is interrupted, or deranged, and a state of atrophy and flaccidity soon follows. The muscles of the opposite side, on the contrary, are constantly called into action, and so retain their full development, or even acquire an increase of it, so that the disparity between the two sides becomes very striking. As by the alteration in the skeleton, the muscles of the left side are placed under circumstances unfavourable to their action, so those of the right, on the contrary, are in a manner stimulated to an increased effort, and with peculiar advantages. The fibres of some of them, particularly of the cervicalis ascendens and multifidus spinæ, are put on the stretch, inasmuch as their points of attachment are separated to a wider interval than natural; for where a lateral curvature exists, the spinous process of a given vertebra is carried, by its deviation from its original position, farther away from the transverse process of the one next, or second next below it; and as the fibres of the last-named muscle are extended obliquely between these points, they must necessarily be stretched and thrown into action. Now by the position in which the vertebral column is placed, the spines become relatively the fixed attachment of the multifidus muscle, so that its fibres, acting on the transverse processes (of the right side, as all this reasoning is made to bear on the supposition of a left lateral curvature) draw them upwards, depressing at the same time those of the opposite side, and with them the bodies of the vertebræ, thus increasing the curve. The action of the cervicalis ascendens has a similar tendency. Its cervical attachment being drawn away somewhat from the costal one, and becoming relatively fixed by the condition of the spine, its fibres necessarily draw on the ribs of the corresponding side, elevating them, together with the transverse processes, by which means those of the opposite side are proportionally depressed, and the curvature increased. If in such circumstances attention were confined to the action and power of the superficial muscles (trapezius and latissimus) and no consideration made of the deep-seated ones, it might be hastily concluded, that as by giving the latissimus dorsi and trapezius a fixed point of action at the humerus, they are enabled to rectify casual curvatures, induced during various motions of the body, so in the pathological condition of the spine, they may, by the same means, be enabled to exert a similarly beneficial influence. But the remarks here offered point out the fallacy of such a conclusion, and indicate at the same time the necessity of suspending, as much as possible, the action of the muscles of the right side, in cases of left lateral curvature, and *vice versa*, and of exerting in a moderate degree those of the opposite side. These observations are made, chiefly with a view to attract a greater degree of attention to the anatomy of this part of the muscular system than is usually paid to it.

365. The *rectus capitis posticus major* (*axoïdo-occipital*, Chauss.) is situated along the middle line, close to the vertebræ, extending from the spinous process of the axis to the under surface of the base of the skull. It arises by a pointed origin from the process just mentioned, and, gradually enlarging as it ascends, is inserted into the inferior transverse ridge of the occipital bone. It diverges somewhat from the corresponding muscle of the opposite side, and is covered by the complexus.

366. The *rectus capitis posticus minor* (*atloïdo-occipital*) extends from the atlas to the base of the skull, being smaller every way than the preceding. It arises from the posterior border of the atlas, and is inserted into the rough surface, between the inferior curved ridge, on the occipital bone, and the foramen magnum. It lies nearer to the middle line than the preceding muscle, and can therefore be seen without disturbing it.

367. The *obliquus capitis inferior* (*axoïdo-atloïdien*) is placed obliquely between the two first cervical vertebræ. It arises from the spinous process of the axis, between the origin of the rectus posticus major, and the insertion of the

spinalis colli, and is inserted into the extremity of the transverse process of the atlas.

368. The *obliquus capitis superior* (*atloïdo-sous-mastoïdien*) extends from the atlas to the lateral and inferior part of the base of the skull. It arises from the extremity of the transverse process of the first cervical vertebra, inclines from thence obliquely upwards and inwards, expanding somewhat as it ascends, and is inserted close behind the mastoïd process, into the interval between the transverse ridges of the occipital bone. These two muscles are covered by the complexus, and correspond, the one with first intervertebral space, the other with that between the atlas and occiput.

The actions and uses of these muscles shall be considered after we have examined the rest of the muscular apparatus employed in the different movements of the head.

369. The *arteries* of the posterior part of the trunk are derived, in the lumbar region, from the ileo-lumbar and lumbar branches; in the dorsal, from the inter-costal branches, and in the cervical, from the cervicalis profunda, the vertebral, and the occipital. These shall be described with the vessels from which they proceed. The *veins* of the spinal column form a system in themselves, marked by several peculiarities; their description must follow that of the medulla spinalis and its investments. The *nerves* are supplied by the posterior sacral, the lumbar, inter-costal, and cervical branches, and must likewise be deferred for the present.

Dissection.—The subject being turned prone, the chest and abdomen should be supported by blocks, and the arms allowed to hang over the sides of the table. An incision may be made through the integument, along the spinal column, from the occipital protuberance to the sacrum. This should be bounded at its superior extremity by a transverse incision, carried outwards to the mastoïd process, and below by another extended along the spine of the ileum. The intervening space may, in the next place, be intersected by two lines, one drawn from the first dorsal vertebra, over the spine of the scapula, the other commencing at the last dorsal vertebra, and carried horizontally outwards. As the space here marked out is so very extensive, it may be advisable to make an incision obliquely upwards from the last dorsal vertebra to the spine of the scapula, which will correspond with the lower border of the trapezius muscle; and the dissection may be commenced by raising the angular flap of skin thus included, proceeding in the direction of the fibres of that muscle, that is to say, from below upwards and outwards. The other portions of integument should be successively raised, taking care to expose accurately the tendinous fibres where they arise from the spinous processes, as they afford a guide to the fleshy part of the muscle. When the latissimus and trapezius have been exposed and examined in their entire extent, which will take some time, in consequence of the quantity of surface that is to be gone over, they are to be removed, in order to bring into view the muscles that lie beneath them. For this purpose, the fibres of the trapezius may be detached from their connexion with the clavicle and spine of the scapula, and reflected back to the spine. This will be found easier than the usual plan of detaching it from the latter, both because it is there very thin, and also because its fibres are connected with those of the rhomboïd muscle. Its dorsal portion conceals the last-named muscle, and part of the latissimus dorsi; and the cervical, the levator scapulæ, the splenius, and complexus. These may be dissected in the course of their fibres, as the trapezius is being reflected back towards the middle line, parallel with which it may be separated from its fellow of the opposite side along the cervical region, so as to expose the ligamentum nuchæ. The rhomboïdei may, in the next place, be detached from the spine of the scapula, and reflected backwards, which is also the easier mode of attaining the end desired, and avoids any risk of raising with it the serratus superior, which is intimately connected with its origin. The aponeurosis of the latissimus dorsi may be divided by an incision carried from above downwards, along its middle, and as the external half is reflected outwards, its intimate connexion may be observed with the obliquus abdominis, along the border of the deep lumbar muscles. The other portion of the aponeurosis may be raised from without inwards, by which means the serratus posticus is left untouched. The serrati and their connecting membrane may be inspected and removed. The erector spinæ and its divisions, the sacro-lumbalis and longissimus dorsi, may then be traced from below upwards, by merely passing the handle of the scalpel along the cellular interval which separates them; and when the splenius has been detached from the vertebræ and reflected outwards, the transversalis colli and trachelo-mastoïdeus can be followed along the neck, taking them as continuations of the long dorsal muscles. The complexus should now be raised from the transverse processes of the vertebræ, and drawn outwards, by which means the recti and obliqui capitis are exposed, and also beneath them the spinalis colli. Finally, the spinalis dorsi will be observed between the longissimus dorsi and the spinous processes; and when these muscles are removed, that series of oblique muscular and tendinous fibres is exposed which constitutes the multifidus spinæ.

CHAPTER VI.

SECTION I.

THE MUSCLES OF THE UPPER EXTREMITY.

370. THE muscles of the upper extremity, taken in the order of their situation, may be divided into four groups, viz. those placed on the shoulder, those on the arm, on the fore-arm, and on the hand. We must however commence the description of the moving powers of the limb, with that of the two pectoral muscles, and the serratus magnus.

371. The *pectoralis major* (*sterno-costo-clavio-humeral*) is placed on the anterior and upper part of the thorax, and in front of the axilla. It is broad and expanded at the former situation, narrowing gradually towards the latter, and *arises* from the sternal half, or a little more, of the clavicle,—from half the anterior surface of the sternum, extending as far down as the insertion of the cartilage of the sixth rib, and from the cartilages of the true ribs, except the first and last. In some cases also a fleshy slip is derived from the aponeurosis of the obliquus externus, where it covers the rectus muscle. From this extensive origin the fleshy fibres proceed, converging towards the tendon of insertion; those from the clavicle, which are usually separated from the rest by a cellular interval, pass downwards and outwards, those from the lower cartilages obliquely upwards, the middle set horizontally. The muscular fibres become continuous with those of the tendon, and still retain their original direction as they proceed to their respective points of insertion into the humerus; and as the superior fibres descend, whilst the inferior ones ascend, the latter passing behind the former, their arrangement gives to the muscle a folded or twisted appearance along its axillary border.

The flat portion of the muscle here described, after being extended across the axilla, is inserted into the anterior border of the bicipital groove in the humerus, its cutaneous surface being muscular, the axillary tendinous. *Direction*—the superior fibres descend a little as they pass outwards; those immediately below them are horizontal; the rest ascend with increasing degrees of obliquity: *structure*—aponeurotic at its internal and external attachments, fleshy in the rest of its extent: *relations*—the aponeurotic fibres of its internal border decussate with those of the corresponding muscle in front of the sternum; the inferior border overlaps the serratus magnus, and the superior runs parallel with that of the deltoïd muscle, from which it is only separated by the cephalic vein, and a small artery. The anterior surface is sub-cutaneous in the greater part of its extent, being only covered by some of the fibres of the platisma myoïdes, and by the mamma. The posterior surface, besides the sternum, clavicle, and ribs, is in relation with the pectoralis minor, subclavius, and serratus magnus muscles, which it covers, and also with the axillary vessels and nerves. The lower border of this muscle is at first separated from that of the latissimus dorsi by a considerable interval, in which may be observed the fibres of the serratus magnus; but they gradually converge towards the axilla, forming its folds or borders.

372. The *pectoralis minor* (*costo-coracoïdien*) lies at the superior part of the thorax, covered altogether by the preceding muscle, and extended obliquely across the axilla. It *arises* from the external surface of the third, fourth, and fifth ribs, near their cartilages, its margin being usually dentated, so that some of the older anatomists named it serratus anticus minor. The fleshy fibres, as they proceed obliquely upwards and outwards, converge to a narrow tendon, which is inserted into the inner and upper border of the coracoïd process near its extremity. Its direction and structure have been here sufficiently indicated. *Relations*—the an-

terior surface is covered by the pectoralis major, the posterior crosses the axillary vessels and nerves.

373. The *subclavius* (*costo-claviculaire*) is placed along the interval between the clavicle and first rib. It *arises* by a small short tendon from the cartilage of the first rib, close to the rhomboïd ligament, from which it is directed outwards beneath the clavicle, forming a rounded fleshy fasciculus, which is inserted into the grooved and rough surface, along the costal aspect of the clavicle, for nearly half its length. *Relations*—its upper surface is covered by the clavicle, a small part beneath it being overlapped by the pectoralis major, but which is at first not perceptible, until a dense fascia that covers it is dissected off; the costal surface lies in front of the subclavian vessels as they pass down from the neck.

374. The *serratus magnus* (*costo-basi-scapulaire*) is placed upon the upper and lateral parts of the thorax, between the ribs and scapula, being deeply seated in far the greater part of its extent. Its anterior border presents eight or nine fleshy points or digitations, giving it a serrated appearance, whence its name is taken. By these, as its points of attachment, it *arises* from the surface of the eight superior ribs; for it is generally found, that two of the processes come from the second rib, or, at all events, the one arising from it is larger than any of the others, and not unfrequently of a deeper colour. From this extensive origin, the fibres of the muscle, forming a flat, thin plane, converge as they proceed backwards, and are inserted into the base of the scapula, being interposed between the subscapularis on the one side, and the rhomboïdei and levator anguli scapulæ on the other. *Structure*—fleshy in its entire extent. If the muscle be put on the stretch by drawing the scapula backwards, its fibres will be observed to be arranged in flat fasciculi, traceable from its serrated border, and distinguished from one another by deep linear impressions: *relations*—one surface rests on the superior ribs, the

intercostal muscles, and part of the serratus posticus superior; the other is subcutaneous in the angular interval between the pectoralis and latissimus dorsi; higher up it is covered by both the pectoral muscles; in the rest of its extent it is in relation with the subscapular muscle and the axillary vessels. The greater number of its fibres will be observed to converge towards the angles of the scapula, particularly the lower one.

Combined actions.—The most obvious actions of these muscles are exerted upon the shoulder and arm, as being their more moveable points of attachment. The pectoralis major, conjointly with the latissimus dorsi and teres major, depresses the humerus, if it has been previously elevated; it then conspires with them in pressing the arm closely to the side, and continuing the same effort, will by itself trail it along the side and front of the chest. The pectoralis minor draws the point of the shoulder downwards and inwards to the thorax. If the arms be fixed, these muscles act on the ribs, and assist in dilating the chest. This is frequently observed during the forcible efforts at inspiration made by asthmatic persons; the arms are rendered fixed, by seizing hold of some object, and so every muscular effort is called into play that can elevate the ribs. When the scapula is rendered fixed by the trapezius and rhomboïd muscles, the serratus acts on the chest in the same way as the pectoral muscles do; but its most ordinary action is to draw the base and inferior angle of the scapula forwards, so as to elevate the point of the shoulder by means of the rotatory motion it can impress upon it conjointly with the trapezius, as has been observed when treating of the latter muscle. The continuation of the same effort retains the shoulder elevated, as when a burden is sustained upon it; but, as a preparatory measure, the thorax must be fixed. This is effected by taking a full inspiration, so as to distend the chest, the lower border of which is kept fixed by the abdominal muscles and diaphragm, at the same time that the glottis is closed, to prevent the escape of the air. This adjustment of the containing and contained parts of the thorax can of course exist but for a very short time, the included air must be expired in order that it may be renewed, and during the expiration, the walls of the thorax, and the shoulder with them, must be allowed to sink down. A new volume of air being inspired, the series of muscular efforts above detailed again succeeds; and if this alternation of action and relaxation be kept up for any time, a considerable degree of distress is induced. Whilst any considerable muscular exertion is being performed, the thorax must be fixed, and retained so by preventing the escape of the included air. This may be inferred from observation on what takes places under such circumstances, but was reduced to the test of experiment by M. Bourdon.* He opened the trachea, or larynx of a dog, that had been in the habit of jumping and tumbling when bidden; after which, the animal was no longer able to make any similar efforts, though evidently willing to do so. But when the aperture was closed, by drawing the margins of the wound together, the lost power was instantly restored.

The muscles of the shoulder are the deltoïd, the supra-spinatus, infra-spinatus, teres minor, teres major, and subscapularis.

375. The *deltoïd* (*sous acromio-humeral*) is situated at the superior and external part of the arm, covering in the shoulder-joint; its form is triangular, the base above, and the apex below. It *arises* from the external third of the clavicle, from the lower border of the acromion, and from the spine of the scapula, as far back as the small triangular surface in which it terminates; and is inserted into the rough prominence on the middle of the outer side of the humerus. *Direction*—the middle fibres descend perpendicularly, the anterior and posterior converge to these as to a common point: *structure*—fleshy and tendinous at its base, tendinous at its apex, fleshy in the rest of its extent; *relations*—by the outer surface with the platisma myoïdes and integuments; by the inner surface with (proceeding from before backwards) the tendon of the pectoralis major, the circumflex vessels and nerves, the outer side of the

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humerus, the fibrous capsule of the shoulder joint, the coracoïd process, the pectoralis minor, coraco-brachialis, biceps, subscapularis, coraco-acromion ligament, the external rotator muscles, and the triceps; by the anterior border, with the pectoralis major, from which it is separated by the cephalic vein, and more inferiorly with the biceps; the posterior border is free.

376. The *supra-spinatus* is placed at the superior part of the shoulder in the supra-spinous fossa of the scapula. Its form is elongated and triangular. It *arises* from the posterior two-thirds of the fossa above mentioned, and is inserted into the superior surface of the greater tuberosity of the humerus. *Direction*—oblique from behind forwards, and from below upwards: *structure*—tendinous at the humeral end, fleshy in the rest of its extent: *relations*—by the outer surface, with the trapezius, coraco-acromion ligament and deltoïd; by the inner surface with the scapula and the ligamentum proprium posticum, with supra-scapular nerve and vessels, omo-hyoïdeus muscle, and the fibrous capsule of the shoulder joint, with which it is intimately united.

377. The *infra-spinatus* occupies the chief part of the infra-spinous fossa, and *arises* from the lower surface of the spine of the scapula, and from all the convex part of its dorsum. The fibres converge to a tendon, at first concealed in a great degree within the substance of the muscle, but which afterwards proceeds forwards over the capsular ligament of the joint, to be inserted into the upper border of the great tuberosity of the humerus. *Direction* from behind forwards, the superior fibres being nearly horizontal, the inferior ones converging to meet them: *structure*—tendinous at the humeral end, and for some way along its centre, fleshy in the rest of its extent: *relations*—the posterior surface is covered, partly by the deltoïd, the latissimus, and trapezius, a small part also being sub-cutaneous; the ante-

rior rests on the bone and capsular ligament. The lower border is in contact with the teres minor, being united posteriorly with it and the teres major.

378. The *teres minor* lies along the inferior border of the scapula; its form is elongated, narrow, and round. It *arises* by a series of oblique fibres from the dorsal surface of that ridge which surmounts the axillary border of the scapula, and from two aponeurotic septa, placed between it and the infra-spinatus and teres major muscles. Its insertion lies immediately below that of the infra-spinatus, into the greater tuberosity of the humerus. *Direction*—oblique from below and upwards and forwards: *structure*—tendinous at its humeral end, fleshy in the rest of its extent: *relations*—by the outer surface with the integuments and deltoïd muscles, by the inner with the scapula, the posterior or dorsal branch of the subscapular artery, the long head of the triceps muscle, and the fibrous capsule of the shoulder-joint. The upper border lies in contact with the infra-spinatus, the lower with the teres major, but is separated anteriorly from it by the long head of the triceps; the posterior extremity is, as it were, inserted between the teres major and infra-spinatus, being connected with both, as has been above stated. The three flat surfaces marked on the upper border of the great tuberosity of the humerus give insertion to these three muscles, taken in their regular order, from above downwards.

379. The *teres major* extends from the inferior angle of the scapula, to the humerus, contributing to form the posterior border of the axilla. It is rather broad and compressed than round, as its name would imply. It *arises* from the flat expanded surface placed at the inferior angle of the scapula, and from the septa interposed between it and the teres minor and infra-spinatus. Its insertion takes place by a broad, flat tendon, into the posterior border of the bicipital groove in the humerus, being in close contact with the tendon of the latissimus dorsi. Its direction must

necessarily vary according to the different positions of the scapula and humerus. Towards their insertion its fibres descend somewhat, whilst those of the latissimus ascend, so that its border is placed lower down than that of the latter muscle. *Structure*—tendinous at its insertion, fleshy in the rest of its extent: *relations*—its posterior surface is covered by the latissimus dorsi and integument, and crossed by the long head of the triceps; the anterior, in part of its extent, is in contact with the latissimus, (in consequence of the change of direction of the latter) and slightly with the coraco-brachialis and brachial vessels.

380. The *sub-scapularis* fills up the hollow of the scapula, lying between that bone and the thorax, from which however it is separated by the serratus magnus muscle. It *arises* from the entire surface of the sub-scapular fossa, its fibres being divided into two or three bundles by aponeuroses connected with the prominent lines marked on the bone. From this extensive origin the fibres converge to a thick tendon, which, after being intimately united with the capsular ligament, is inserted into the lesser tuberosity of the humerus: *direction*—from behind forwards, the superior fibres being nearly horizontal, the inferior ascending obliquely: *structure*—tendinous at its humeral extremity, fleshy in the rest of its extent: *relations*—by the outer, or posterior surface, with the scapula, and the fibrous capsule of the shoulder, to which it is intimately adherent, by the inner, or anterior surface, with some loose cellular tissue separating it from the serratus magnus, and the brachial plexus of nerves.

Actions.—The deltoïd can raise the arm directly from the side, so as to bring it at right angles with the body; after which, by means of its anterior and posterior fibres, it can carry the limb alternately backwards and forwards, being assisted in the former movement by the teres major and latissimus dorsi, in the latter by the pectoralis major. The mass of its muscular fibres is so considerable that it is enabled, by pressing down the head of the humerus, to make it glide upon the surface of the glenoïd cavity of the scapula, and then, by continuing the effort, to raise the limb directly upwards, so as to bring it to the vertical position. Its only assistant in elevating the arm is the supra-spinatus, whose power in this respect must be very trivial, as it is inserted so near the centre of motion.

The supra-spinatus, infra-spinatus, and teres minor, are the external rotators of the arm, whilst the sub-scapularis rotates it inwards; for, as they are opposed in situation, so they are antagonists in action. The power of these muscles is increased in no small degree, by passing over the globular head of the humerus, and also by being inserted into the prominent processes of bone which remove the line of their direction to a distance from the axis of the humerus. The teres major conspires with the latissimus dorsi in its actions; it depresses the arm, if raised, and rotates it on its axis. If the arm be fixed, as when, in the reclining posture, the elbow is removed from the side, these muscles, particularly the teres major, assisted by the long head of the triceps, can approximate the lower border of the scapula to the shaft of the humerus, thus conspiring with other muscles, viz., the pectoralis and latissimus dorsi, to trail the body after the outstretched limb.

This power of moving the scapula on the humerus affords no inconsiderable security against the occurrence of dislocations. Accidents of this sort would take place even more frequently than they do, in consequence of the great mobility of the joint, and the total absence of any mechanical contrivance to keep the bones in contact, but that the rotator muscles, by their intimate connexion with the capsular ligament of the joint, as well as by their own contraction, tend to retain the head of the humerus in its natural situation. But all this would not suffice during very extensive movements of the limb, were not the scapula also moveable. When the arm is raised into the perpendicular position, the inferior angle of the scapula is instantly drawn forwards, so that the glenoïd cavity is made to look upwards, and thereby kept in the same relative position with the head of the humerus. Were it not for this process of adaptation, the head of the bone would rest against the lower part of the capsular ligament, where it is altogether unsupported, and would, therefore, very easily be made to slide off the articular surface of the scapula, and be luxated.

The muscles of the arm are the coraco-brachialis, the biceps flexor, the brachialis anticus, and triceps extensor.

380. The *coraco-brachialis* is placed along the superior and inner part of the arm, for about half its length. It *arises* from the coracoïd process of the scapula, between the pectoralis minor and the short head of the biceps, also from the tendon of the latter, with which it is intimately united for some way. The fleshy fasciculus thus formed passes downwards and a little outwards, to be inserted into the inner side of the humerus about its middle, where it is interposed between the brachialis anticus and triceps. *Direction*—nearly vertical: *structure*—aponeurotic at its attachments, fleshy in the middle: *relations*—its anterior surface is covered above by the deltoïd and pectoralis major, and at its insertion is crossed by the brachial artery. The posterior surface runs over the tendon of the sub-scapularis, and those of the latissimus dorsi and teres major, the axillary vessels intervening; one border is in apposition with the biceps, the other with the brachial artery; its belly is usually pierced by the external cutaneous nerve.

381. The *biceps flexor cubiti* (*coraco-scapulo-radial*) lies along the anterior part of the arm for its entire length. Superiorly it is divided into two heads, whence its name is derived. Of these the *internal*, or short *head arises*, conjointly with the coraco-brachialis, from the extremity of the coracoïd process, from which it descends and unites at an acute angle with the *external* or long head, which *arises* from the upper border of the glenoïd cavity, where it is also connected with the fibrous rim, which surrounds that cavity. The tendon passes over the globular head of the humerus, enclosed in a sheath formed of the synovial membrane of the joint, and, after piercing the fibrous capsule, and descending some way in the groove appropriated for it, unites, as above stated, with the short head. The long, rounded, fleshy belly thus formed, ends near the bend of the arm, in a flat tendon, which sinks deeply between

the muscles of the fore-arm, and is inserted into the posterior part of the tubercle of the radius. *Direction*—vertical: *structure*—tendinous at its extremities, fleshy in all the rest of its extent. From the tendon of insertion a fibrous expansion, presenting an arched border, is sent off, as it is about to sink between the muscles of the fore-arm. This process passes obliquely downwards and inwards, and becomes blended with the fascia of the fore-arm, somewhat below the inner condyle; it is stretched across the brachial artery, median nerve, and part of the pronator teres muscle: *relations*—the anterior surface is overlapped superiorly for some way, by the deltoïd and pectoral muscles; but, in all the rest of its extent, it is subcutaneous. The posterior surface, for about half its length, rests on the humerus and shoulder joint, and in the rest, on the brachialis anticus, being separated from the latter by the external cutaneous nerve. The inner border is in contact with the coraco-brachialis, for half its length, with the brachial artery for the rest.

382. The *brachialis anticus* (*humero-cubital*) lies under cover of the biceps, along the lower half of the arm. It is somewhat compressed in its form, and broader in the middle than at the extremities. It *arises* from the fore-part of the humerus, commencing at the insertion of the deltoïd, which it embraces by two angular fleshy processes, and extending nearly to the border of the trochlea. Some fibres also arise from the intermuscular septa on each side. These, after passing in front of the elbow joint, end in a thick fasciculus of tendinous fibres, which is inserted into the rough surface on the fore-part of the coronoïd process of the ulna. *Direction*—the middle fibres are vertical, those on each side converge a little to them: *structure*—tendinous at its insertion, fleshy in the rest of its extent: *relations*—the posterior surface rests on the bone and capsular ligament; the anterior, partly concealed by the biceps, projects some-

what at each side of it, and supports the brachial artery and median nerve.

Combined Actions.—The most obvious action of the biceps is that of bending the fore-arm, in which it conspires with the brachialis anticus; it also serves to render tense the fascia of the arm by means of the process which connects its tendon with that membrane. If the arm be placed in the prone position, the biceps can turn it supine, being in this particular the direct antagonist of the pronator radii teres. When the fore-arm is rendered fixed by holding some firm object, the biceps and brachialis muscles can draw on the humerus, and bend it forwards on the arm, which is exemplified in the effort of climbing. They also can move the humerus on the scapula, but their influence in this respect must be very limited, as they run parallel with the axis of the bone. When the humerus is fixed, these muscles, by drawing on the coracoïd process, move the scapula, and therefore the glenoïd cavity on the head of the bone, so that the latter may receive support from the former, rather than that it should be pressed up against the capsular ligament solely.

383. The *triceps extensor cubiti* rests against the posterior surface of the humerus for its entire length, being the only muscle that lies behind the bone and inter-muscular septa. Superiorly it is divided into three processes or heads, whence its name is derived, whilst its lower half, or more, remains single and undivided. In order to facilitate its description, we shall adopt Bichat's plan, and commence at the lower extremity of the muscle. The triceps then is attached to the summit and sides of the olecranon, by a strong tendon, which gradually expands into a wide aponeurosis, that covers the posterior aspect of the muscle, for about half its length. From the anterior, or humeral surface of this aponeurosis the fleshy fibres arise and proceed, with varying degrees of obliquity, to be inserted into the posterior surface of the humerus, and the inter-muscular septa, thus forming a thick, fleshy mass, which continues

undivided as far as the middle of the bone. There it begins to be separated into its three heads. Of these, the *posterior*, or *long* head, ascends vertically, and narrows into a flat fasciculus (fleshy and tendinous) which is inserted into the lower border of the scapula, immediately behind the glenoïd cavity. The *internal*, or *short head*, that is to say, the fibres which compose it, ascend along the inner margin of the humerus, and are inserted into each and every point of it, as far as the lower border of the teres major, where they end in a pointed process. Lastly, the *external*, or *middle head*, intermediate in length between the two others, proceeds along the external border of the humerus, gradually diminishing in size, until it ceases also by a pointed process, just below the insertion of the teres minor, into the greater tuberosity. *Direction*—vertical: *relations*—its posterior surface is covered merely by the skin and fascia of the arm; the anterior rests against the humerus, from which it is separated, for an inch above the elbow joint, by a cellular interval, and, higher up, by the spiral nerve and profunda artery. These vessels also separate the second from the third head; and, where they pass between the former and the bone, they are protected from pressure by some tendinous fibres that arch obliquely over them. The long head is overlapped, near its insertion, by the deltoïd, and is there interposed between the teres major and minor.

Actions.—When the fore-arm is flexed, the triceps, by drawing on the extremity of the ulna, is enabled to extend it on the humerus, and so bring both parts of the limb into a right line. In situation, as well as in action, it is thus the direct antagonist of the biceps and brachialis anticus. When the arm is in the extended position the long head of the triceps may assist, in some degree, the teres and latissimus in carrying it backwards. If the elbow be fixed, the scapula becomes relatively the more moveable point of attachment of the muscle, and then its long head, by acting on the lower border of that bone, can approximate it to the shaft of the humerus.

384. The fleshy mass of the fore-arm consists, 1, of the muscles which move the radius and ulna on one another; 2, of those that act on the carpus; 3, of those that move the fingers. The motions of pronation and supination are effected by two pronators (teres and quadratus) and by the two supinators (longus and brevis). The carpus is acted on by five muscles, it is extended by the extensor carpi radialis (longior and brevior) and extensor ulnaris, and flexed by the flexor carpi ulnaris and radialis. The fingers are bent by the flexor sublimis, and profundus, and flexor pollicis; they are extended by the extensor communis, the two extensors of the thumb, the extensores indices et minimi digiti. In studying the actions of these muscles, they may be reviewed as they are here placed according to a physiological arrangement; but their dissection had better be conducted according to their anatomical order. Taken in this way they may be divided into the following groups; 1, those placed on the anterior and inner part of the arm, which are divisible into two sets, one being superficial, the other deep-seated; 2, those that lie along the radial border of the fore-arm; 3, those situated on its posterior aspect.

The superficial muscles of the anterior and inner part of the fore-arm are, the pronator radii teres, flexor carpi radialis, palmaris longus, flexor carpi ulnaris, and flexor digitorum sublimis. These are all intimately united at their origin from the inner condyle, to which they are attached by a common tendon that gives a fasciculus of fibres to each, and also sends septa between them.

386. The *pronator radii teres* is extended obliquely across the front of the arm at its upper third. It *arises* by two distinct heads; one large and superficial, is derived from the common tendon, from the fascia of the fore-arm, and the septum between this muscle and the flexor carpi radialis. The other head is a thin fasciculus that lies deeply, coming from the margin of the coronoïd process, and joins the other at an acute angle, being previously se-

parated from it by the median nerve. The fleshy belly thus formed proceeds outwards and downwards, to be inserted tendinous into the outer border of the radius about its middle. *Direction*—oblique from above, downwards and outwards: *structure*—tendinous and fleshy: *relations*—its anterior surface is superficial in the greater part of its extent, but towards its insertion it is crossed by the radial artery and nerve, and supinator longus muscle. Its ulnar border is in contact with the flexor carpi radialis, and palmaris longus, the radial bounds, with the supinator longus, an angular space, in which are placed the brachial artery, the median nerve, and tendon of the biceps muscle.

387. The *flexor carpi radialis* is situated in front of the fore-arm, being extended from the inner condyle towards the root of the thumb: it *arises* from the inner condyle by the common tendon, from the fascia of the arm, and from the inter-muscular septa, placed between it and the pronator teres on one side, the palmaris longus on the other, and the flexor sublimis posteriorly. Its tendon passes beneath the annular ligament of the wrist, and runs through a groove in the os trapezium (to which it is bound by a thin, fibrous sheath, lined by a synovial membrane) to be inserted into the extremity of the second metacarpal bone. Its anterior surface is covered by the fascia and integument; the posterior rests on the flexor sublimis, the flexor pollicis, pronator quadratus, and wrist joint. Its tendon lies between those of the supinator radii longus and palmaris longus.

388. The *palmaris longus* lies along the middle of the fore-arm, on the ulnar side of the preceding muscle. It *arises* from the inner condyle and the inter-muscular septa; the small fleshy belly, which it presents superiorly, soon ends in a long, slender tendon, which is inserted into the annular ligament of the wrist, and the palmar fascia. When present, which is not always the case, this muscle is placed

between the flexor carpi radialis and ulnaris, resting on the flexor sublimis.

389. The *flexor carpi ulnaris* lies superficial along the ulnar border of the fore-arm, being extended from the inner condyle to the inner margin of the wrist. It *arises* by two short processes, the angular interval between which transmits the ulnar nerve. One of these is attached to the inner condyle, the other to the border of the olecranon. The muscle is also connected, for some distance, to the inner side of the ulna by a dense fascia. The muscular fibres from these different points of attachment terminate in a tendon, which is inserted into the pisiform bone, and slightly into the base of the fifth metacarpal bone. *Relation*—the anterior surface is covered by the skin and fascia, the posterior rests on the flexor profundus, and overlaps the ulnar nerve and artery.

390. The *flexor digitorum sublimis, vel perforatus,* is placed at the anterior part of the fore-arm, between the preceding muscles and the flexor profundus. It is flat and broad in the upper part, but inferiorly divides into four tendons. It *arises* from the inner condyle, by the common tendon, from the internal lateral ligament, from the anterior surface of the coronoïd process, and from the oblique line extended from the tubercle of the radius to the insertion of the pronator teres. The fleshy belly enlarges towards the middle of the arm, but diminishes somewhat before its division. The four tendons pass under the annular ligament of the wrist, resting on the flexor profundus; and diverge as they proceed to their destinations. Each of these, accompanied by a tendon from the flexor profundus, enters a fibrous sheath, that binds it down to the palmar surface of the finger, and opposite the first phalanx it presents a fissured interval, which transmits the tendon of the deep flexor. Finally, after expanding somewhat, and forming a groove, by its palmar surface, which partly encloses the ac-

companying tendon, it is inserted into the forepart of the second phalanx. The same arrangement obtains in each instance. The direction and structure of the muscle have been here sufficiently indicated. *Relations*—superiorly concealed by the other muscles of this set, it rests on the flexor pollicis longus, and flexor profundus, separated from the latter by the median nerve. In the palm of the hand, its tendons are covered by the palmar fascia, the superficial palmar arch of arteries, and the branches of the median nerve. Where the tendons slide beneath the annular ligament they are invested by a synovial membrane, to facilitate their movements.

The deep-seated muscles, on the anterior surface of the fore-arm, are the flexor profundus, flexor pollicis longus, and pronator quadratus.

391. The *flexor digitorum profundus vel perforans* lies deeply along the ulnar border of the fore-arm, covered by all the preceding muscles. It is compressed above, presents in the middle a fleshy belly of considerable size, and, inferiorly, is divided into four tendons. The muscle *arises* from the hollow at the inner side of the olecranon, from the inner border and anterior surface of the ulna, to within a few lines of the edge of the pronator quadratus, and from the ulnar half of the interosseous ligament. The four tendons by which the muscle is continued into the palm, pass beneath the annular ligament, interposed between those of the flexor sublimis and the carpal bones, and maintain the same relation to the latter as they pass along the metacarpal bones and digital phalanges. Opposite the first phalanx of each finger, its tendon passes through the fissure formed for its transmission in the tendon of the flexor sublimis, and proceeds (still bound down by a fibrous sheath) to be inserted into the base of the last phalanx. It is unnecessary to add any thing more as to its direction or structure. *Relations*—its upper extremity in a manner embraces the insertion of the brachialis anticus; the posterior surface

between the flexor carpi radialis and ulnaris, resting on the flexor sublimis.

389. The *flexor carpi ulnaris* lies superficial along the ulnar border of the fore-arm, being extended from the inner condyle to the inner margin of the wrist. It *arises* by two short processes, the angular interval between which transmits the ulnar nerve. One of these is attached to the inner condyle, the other to the border of the olecranon. The muscle is also connected, for some distance, to the inner side of the ulna by a dense fascia. The muscular fibres from these different points of attachment terminate in a tendon, which is inserted into the pisiform bone, and slightly into the base of the fifth metacarpal bone. *Relation*—the anterior surface is covered by the skin and fascia, the posterior rests on the flexor profundus, and overlaps the ulnar nerve and artery.

390. The *flexor digitorum sublimis, vel perforatus,* is placed at the anterior part of the fore-arm, between the preceding muscles and the flexor profundus. It is flat and broad in the upper part, but inferiorly divides into four tendons. It *arises* from the inner condyle, by the common tendon, from the internal lateral ligament, from the anterior surface of the coronoïd process, and from the oblique line extended from the tubercle of the radius to the insertion of the pronator teres. The fleshy belly enlarges towards the middle of the arm, but diminishes somewhat before its division. The four tendons pass under the annular ligament of the wrist, resting on the flexor profundus; and diverge as they proceed to their destinations. Each of these, accompanied by a tendon from the flexor profundus, enters a fibrous sheath, that binds it down to the palmar surface of the finger, and opposite the first phalanx it presents a fissured interval, which transmits the tendon of the deep flexor. Finally, after expanding somewhat, and forming a groove, by its palmar surface, which partly encloses the ac-

companying tendon, it is inserted into the forepart of the second phalanx. The same arrangement obtains in each instance. The direction and structure of the muscle have been here sufficiently indicated. *Relations*—superiorly concealed by the other muscles of this set, it rests on the flexor pollicis longus, and flexor profundus, separated from the latter by the median nerve. In the palm of the hand, its tendons are covered by the palmar fascia, the superficial palmar arch of arteries, and the branches of the median nerve. Where the tendons slide beneath the annular ligament they are invested by a synovial membrane, to facilitate their movements.

The deep-seated muscles, on the anterior surface of the fore-arm, are the flexor profundus, flexor pollicis longus, and pronator quadratus.

391. The *flexor digitorum profundus vel perforans* lies deeply along the ulnar border of the fore-arm, covered by all the preceding muscles. It is compressed above, presents in the middle a fleshy belly of considerable size, and, inferiorly, is divided into four tendons. The muscle *arises* from the hollow at the inner side of the olecranon, from the inner border and anterior surface of the ulna, to within a few lines of the edge of the pronator quadratus, and from the ulnar half of the interosseous ligament. The four tendons by which the muscle is continued into the palm, pass beneath the annular ligament, interposed between those of the flexor sublimis and the carpal bones, and maintain the same relation to the latter as they pass along the metacarpal bones and digital phalanges. Opposite the first phalanx of each finger, its tendon passes through the fissure formed for its transmission in the tendon of the flexor sublimis, and proceeds (still bound down by a fibrous sheath) to be inserted into the base of the last phalanx. It is unnecessary to add any thing more as to its direction or structure. *Relations*—its upper extremity in a manner embraces the insertion of the brachialis anticus; the posterior surface

rests on the ulna, interosseous ligament, and pronator quadratus; the anterior is covered by the ulnar artery and nerve, the median nerve, and the other flexor muscles. The external border is parallel with the flexor pollicis longus, from which it is separated by the anterior interosseous artery.

392. The *flexor pollicis longus* lies on the same plane as the flexor profundus, resting on the radius. It *arises* from the grooved surface on the fore part of the radius, commencing just below the oblique line, extending from its tubercle to the insertion of the pronator teres, and reaching nearly to the edge of the pronator quadratus, also from the adjacent part of the interosseous ligament. The fleshy fibres come forwards to a tendon, which, after passing beneath the annular ligament of the wrist, turns outwards, lying between the two heads of the flexor brevis and the sesamoïd bones; then enters a fibrous sheath similar to those for the other flexor tendons, and finally becomes inserted into the base of the second phalanx of the thumb. *Relations*—its anterior surface is covered by the flexor carpi radialis, flexor sublimis, and somewhat by the pronator teres, also by the radial vessels. Towards the lower part of the arm, its fibres can be readily perceived between the tendon of the supinator longus and flexor carpi radialis.

393. The *pronator quadratus* is extended across the radius and ulna, immediately above their carpal extremity; it is flat and thin, being about two inches in breadth. Its origin, or fixed attachment, is from the inner border of the ulna, in the situation and extent just mentioned. The fibres pass directly across to be inserted into the fore part, and anterior surface of the radius. Its structure is fleshy; one surface rests on the bones and interosseous ligament, the other is covered by the muscles and vessels that pass into the palm of the hand.

Combined Actions.—These muscles act on the fore-arm, the hand, and the digital phalanges. The radius is made to turn on the ulna, and the hand thereby pronated by the pronator teres and quadratus, which take their fixed points, the one on the humerus, the other on the ulna, and draw the radius inwards across the latter bone. Should the pronator teres, after having effected so much, continue its action, it becomes virtually a flexor, and will assist the other muscles in bending the fore-arm on the arm. So also the flexors of the fingers, after having bent the phalanges towards the palm, begin to act on the wrist, and then contribute to the flexion of the fore-arm by means of the mechanical advantage they derive by passing under the annular ligament of the wrist. The flexores carpi too, after having bent the wrist, become, subsequently, flexors of the fore-arm. The flexion of the phalanges is obviously effected by the superficial and deep common flexors, and by the flexor pollicis.

The muscles placed along the outer side of the fore-arm, are the supinator radii longus, and brevis, the extensor carpi radialis longior and brevior.

394. The *supinator radii longus* is the most prominent muscle of this set, and lies upon the radial border of the arm, extended from nearly the middle of the humerus to the end of the radius. It *arises* from the external condyloïd ridge of the humerus, nearly as high up as the insertion of the deltoïd, where it is interposed between the brachialis anticus and the external inter-muscular septum, to which also its fibres are attached. The rounded, fleshy belly thus formed, descends upon the anterior and outer border of the arm, and, about its middle, ends in a flat tendon, which, continuing the same course, is inserted into the external border of the radius, close to the base of its styloïd process. This muscle is covered only by the skin and fascia; it rests on the humerus, extensor carpi radialis (longior and brevior), and the supinator radii brevis. The inner surface is in contact, above the bend of the elbow, with the brachialis anticus, from which it is separated only by the spiral nerve; along the arm, it is in contact with the radial artery and nerve.

395. The *extensor carpi radialis longior* is partly covered by the preceding muscle, but its external border pro-

jects beyond it. It *arises* lower down than the supinator longus, from the external condyloïd ridge, and part of the condyle, as well as from the inter-muscular septum. After passing along the outside of the articulation, it ends, at the upper third of the arm, in rather a broad, flat tendon, which descends along the outer and back part of the radius, passes, conjointly with the following muscle, in a groove in the lower extremity of that bone, and is inserted into the base of the metacarpal bone of the fore-finger. The fleshy part of the muscle lies between the supinator longus and extensor carpi radialis brevior, but is concealed only in part by them; its tendon passes beneath the extensors of the thumb, and the posterior annular ligament of the wrist.

396. The *extensor carpi radialis brevior* lies along the posterior and external aspect of the radius. It *arises* from the extremity of the outer condyle of the humerus, and from the external lateral ligament of the elbow joint. The fleshy belly, lying behind the preceding muscle, ends in a flat tendon, which remains closely applied to that of the latter, and with it proceeds in the groove in the radius, and under the annular ligament, where it diverges somewhat, in order to be inserted into the base of the metacarpal bone of the middle finger.

397. The *supinator radii brevis* is a short triangular muscle lying in close contact with the bones, and extended obliquely from the outer condyle of the humerus over the upper third of the radius. It *arises*, by a short tendon, from the external condyle, and from the external lateral ligament, as far as its insertion into the annular ligament of the radius, also from a rough ridge on the back part of the ulna, and, in the interval between the bones, from a slight band of tendinous fibres stretched from the ridge just mentioned to the condyle. The fibres of the muscle, from these points of attachment, pass obliquely over the head and upper part of the radius, and are inserted into the oblique ridge, that leads from the tubercle of that bone

downwards and outwards to the insertion of the pronator radii teres. It is altogether concealed by the supinator longus and the extensors.

Combined Actions.—These are the direct antagonists of the pronators of the hand, and flexors of the wrist. If the hand be previously pronated, the supinators, by rolling the radius on the ulna, turn the palm supine, but the extent and power of action of each differ considerably. The supinator longus, notwithstanding its length and size, can act but feebly in supinating the hand, inasmuch as its direction is parallel with that of the radius; its direction and attachments indicate it to be a flexor of the fore-arm. The supinator brevis, both by its direction and mode of attachment, is by far the more efficient agent in moving the radius on the ulna. The action of the radial extensors is fully indicated by their name; if their effort be continued they assist in extending the fore-arm on the arm.

The muscles situated on the posterior aspect of the fore-arm are the anconeus, the extensor communis digitorum, extensor carpi ulnaris, and extensor minimi digiti, which are superficial; whilst the rest are deep-seated, viz., the three extensors of the thumb, the extensor indicis, and the supinator radii brevis, which has been already described.

398. The *anconeus* is placed immediately behind and beneath the elbow joint, being a small triangular muscle. It *arises* by a tendinous and fleshy point from the extremity of the outer condyle of the humerus, at its posterior aspect. From this the fibres proceed, diverging from one another, the upper ones being horizontal, the rest passing with increasing degrees of obliquity, but all are inserted into the radial aspect of the olecranon, and adjacent border of the ulna itself. It is superficial in its entire extent, and lies below the triceps extensor, with which it conspires in its action.

399. The *extensor communis digitorum* lies along the posterior part of the fore-arm. It *arises* by a tendon common to it, the extensor carpi ulnaris, and extensor radialis

brevior, also from the fascia of the arm, and the septa between it and the last named muscles. Somewhat below the middle of the fore-arm the muscular part ends in four tendons, which, after passing beneath the posterior annular ligament of the wrist, diverge as they proceed along the carpus and metacarpus. Each of these expands on reaching the fingers, forming a fibrous sheath, which encases the back of the digital phalanges, into which they are thus inserted. At its origin it lies between the extensor carpi radialis brevior, and extensor carpi ulnaris, and maintains the same relation as it descends towards the wrist. It covers the supinator radii brevis, and the extensors of the thumb, at their origin; and as the tendons pass along the metacarpal bones, they are connected to one another by slips of communication passing obliquely between them.

400. The *extensor digiti minimi* is usually united with the common extensor, and has been considered by some as a part of it. It is placed between the muscle last named and the extensor carpi ulnaris. It *arises* in common with the extensor communis, presents, as it descends along the arm, a thin fleshy belly, which ends in a tendon that passes through a ring in the annular ligament appropriated to itself. This will be observed to join with the fourth digital tendon of the common extensor, conjointly with which it expands upon the posterior surface of the phalanges of the little finger.

401. The *extensor carpi ulnaris* lies towards the ulnar border of the fore-arm, being extended from the external condyle to the root of the little finger. It *arises* from the posterior surface of the external condyle by a tendon common to it, the extensor communis, and extensor carpi radialis; some fibres are also derived from the septa that lie between it and these muscles, as well as from the fascia of the arm. The muscle inclines somewhat inwards, and ends in a tendon, which runs through a groove appropriated to it in the carpal end of the ulna, and after

passing between the carpus and annular ligament, is inserted into the posterior extremity of the metacarpal bone, sustaining the little finger. It is covered only by the skin and fascia.

The deep-seated muscles on the back of the arm are all less in size and length than the superficial set, from which they are readily distinguishable by the obliquity of their direction.

402. The *extensor of the metacarpal bone of the thumb* (*ossis metacarpi pollicis; abductor longus pollicis*, Soemm.) descends obliquely over the bones of the fore-arm, lying immediately below the border of the supinator brevis. It *arises* from the external surface of the ulna, as well as from the interosseous ligament and radius, as it crosses each; its fleshy belly ends in a tendon, which passes through a groove in the outer border of the radius, common to it and the extensor of the first phalanx of the thumb, and is inserted into the base of the metacarpal bone of the thumb. The origin and upper part of the muscle are concealed by the common extensor, but it becomes superficial where it lies on the external border of the radius; and whilst passing over the carpus its tendon crosses those of the radial extensors.

403. The *extensor of the first phalanx* (*primi internodii pollicis*) is much smaller than the preceding, and lies close to its lower border. The muscle *arises* from the interosseous ligament and radius, and slightly, if at all, from the ulna; it takes the same direction as the abductor, which it accompanies through the groove in the radius, and over the corresponding border of the carpus; its tendon proceeds onwards to the thumb, and is inserted into its first phalanx.

404. The *extensor of the second phalanx* (*secundi internodii pollicis*) is much larger than the preceding muscle, which it partly covers; its direction is obliquely downwards and forwards from the ulna to the thumb. It *arises* from the back part of the ulna, immediately below the great abductor, and from the adjacent part of the interosseous

ligament. The fleshy belly derived from these attachments soon ends in a tendon, which, like the others, is bound down by the annular ligament, and runs through the narrow oblique groove at the middle of the carpal end of the radius, and is finally inserted into the base of the second phalanx of the thumb. Whilst passing along the groove, its tendon is separated from those of the other extensors of the thumb, by the breadth of the interval which lodges the radial extensors, but it gradually inclines towards them, as it proceeds to its destination.

405. The *extensor indicis* is nearly of the same size as the preceding muscle, whose lower border it accompanies. It *arises* from the posterior surface of the ulna, about its middle, also from the interosseous ligament. The tendon, which is continued from the muscular part, passes, together with the common extensor, beneath the annular ligament, comes into contact with the digital tendon of the latter, which is destined for the index finger, and unites with it to form the tendinous expansion by which both are inserted into the posterior surface of the phalanges.

Combined Actions.—These muscles act on the hand and fingers in the first instance, and then, by a continuance of their effort, on the fore-arm, which they assist in extending. The common extensor, as well as those of the thumb, the fore-finger, and little finger are, from their situation and attachments, the direct antagonists of the flexors; the latter, however, being, from their size and number, the more powerful agents. If the bones of the thumb be drawn inwards to the palm, as when an object is firmly grasped, their extensor muscles may, by reason of the obliquity of their direction, assist in supinating the hand. Their names indicate their more ordinary action. The anconeus assists the triceps in extending the fore-arm.

The muscles of the hand, like those of the foot, admit of being divided into three sets or groups, viz. those of the thumb, those of the little finger, and thirdly, those placed in the middle of the palm.

The fleshy mass that forms the ball of the thumb, consists of four muscles, which are inserted into its metacarpal bone and first phalanx.

406. *a.* The *abductor pollicis* is a flat, thin muscle, placed immediately beneath the skin. It arises from the annular ligament of the wrist, and from the os trapezium, and proceeds outwards and forwards, to be inserted, by a short thin tendon, into the base of the first phalanx of the thumb, at its radial border. The muscle is superficial in its entire extent, and rests on the opponens pollicis.

407. *b.* The *opponens pollicis* is placed beneath the preceding, but its borders project laterally, so as to be perceptible at each side of it. The fibres of the muscle arise from the annular ligament, and from the os trapezium, and thence proceed outwards and forwards, to be inserted into the whole length of the metacarpal bone of the thumb, at its radial border. One surface is covered by the abductor and integument, the other rests on the short flexor.

408. *c.* The *flexor brevis pollicis* is larger than either of the preceding muscles, beneath which it is placed. Its carpal extremity is divided into two processes or heads, the interval between which transmits the tendon of the long flexor. One of these, which is anterior, and therefore superficial, relatively to the other, arises from the inner surface of the annular ligament, and from the os trapezium; the other is attached to the os trapezoïdes and os magnum. The fleshy fibres from these points of origin soon unite to form a single mass, which however again resolves itself into two short processes, which are inserted into the opposite borders of the base of the first phalanx of the thumb. In each of these tendinous heads a sesamoïd bone is placed, where it passes over the first joint of the thumb.

409. *d.* The *adductor pollicis* is placed still more deeply than the short flexor, being extended from the metacarpal bone that sustains the middle finger, to the base of the first

phalanx of the thumb. Its form is triangular, the base being attached to the former bone, the apex to the latter. It arises from the palmar border of the third metacarpal bone, from which its fibres proceed outwards, converging to a short tendon, which is inserted into the base of the first phalanx of the thumb, where its fibres are blended with the inner insertion of the short flexor.

Combined Actions.—The names applied to the muscles of the thumb sufficiently indicate their actions and use; they are eight in all, and may be arranged as follows. In the first place, it should be recollected that there are three moveable osseous pieces in the thumb, so articulated as to admit of the four movements of extension, flexion, abduction, and adduction. There are three extensors, one for each bone, viz. the extensor of the metacarpal bone, and those of the first and second phalanges; these are long muscles, placed on the dorsal aspect of the fore-arm and hand. Opposed in situation and action to these are the three flexors, lying on the palmar aspect of the thumb, viz. the opponens (which may be considered a flexor of the metacarpal bone), the flexor brevis, or flexor of the first phalanx, and flexor longus, being the flexor of the second phalanx. There remain the abductor and adductor, which likewise are opposed to one another in situation and action; one being superficial and external, and therefore well calculated to draw the thumb away from the other fingers, whilst the other is internal and deep-seated, and thereby enabled to approximate it to them. If these moving powers be made to act successively, circumduction is performed, or in other words, the thumb moves so as to describe a cone, whose summit is at its carpal articulation, and base at the line traversed by its extremity.

The thick fleshy mass at the inner border of the hand also consists of four muscles, one of them being cutaneous, the others are the proper muscles of the little finger.

410. *a.* The *palmaris brevis* forms a thin plane of fibres placed immediately beneath the skin. It arises from the annular ligament and palmar fascia, from which its fibres proceed inwards, diverging, and are inserted into the skin

along the inner border of the palm of the hand. It is superficial to the palmar fascia, as well as to the muscles of the little finger.

411. *b.* The *abductor digiti minimi* runs along the ulnar border of the palm of the hand, arising by tendinous fibres from the pisiform bone and annular ligament, where they are blended with the insertion of the flexor carpi ulnaris. The fleshy belly, of which the muscle consists, ends in a tendon, which is inserted into the base of the first phalanx of the little finger, at its ulnar border. The muscle rests on the fifth metacarpal bone, and on the opponens or adductor of the little finger, and is covered by the palmaris brevis and palmar fascia.

412. *c.* The *flexor brevis digiti minimi* is placed on the same plane with the abductor, lying close to its palmar border. It arises from the anterior surface of the annular ligament, and from the unciform bone, and is inserted into the base of the first phalanx of the little finger. In some instances the flexor does not exist, in which cases the abductor is found larger than usual. From this circumstance, as well as from its position and direction, it may be inferred, that, in addition to its ordinary action of abduction, the last named muscle can become also a flexor.

413. *d.* The *adductor vel opponens digiti minimi*, is somewhat triangular in its form, and placed under cover of the others. It arises from the annular ligament, and from the unciform bone, from which the fibres incline forwards and inwards, to be inserted into the whole length of the fifth metacarpal bone.

The muscles placed in the space intervening between the two borders of the hand, are the lumbricales and interossei.

414. The *lumbricales* are four tapering, fleshy fasciculi, extended from the tendons of the flexor profundus, to the first digital phalanges, and are therefore but accessories or appendages to that muscle. They arise by fleshy fibres

from the outer or radial border of the flexor tendons, and proceed forwards to the corresponding sides of the fingers, where they are inserted into the tendinous expansion, covering the dorsal aspect of the fingers. They are covered by the palmar fascia, and partially by the tendons of the flexor sublimis.

The *interossei* are divided into two sets, viz. those that are perceptible at the dorsal aspect of the metacarpus, and those placed in the palm.

415. The dorsal interossei are four in number, one of them being usually known as the abductor indicis, and usually placed amongst some of the other groups of muscles, though in position, mode of attachment, and structure, it is strictly analogous to the other individuals of this set. The general characters of these muscles, like the corresponding group in the foot, are, that they lie between the metacarpal bones, and appear on their dorsal aspect, yet project into the palm. They arise from the contiguous sides of the bones, between which they are placed, by fibres that converge to a common tendon; each is moreover bifid at its carpal extremity.

416. *a.* The *first* interosseous muscle (*abductor indicis*) is larger than the others, and lies in the interval between the thumb and index finger. It arises by two heads, of which one, external and larger, is attached to the ulnar border of the first metacarpal bone, the other to the contiguous margin of the second, the angular interval between them serving to transmit the radial artery into the palm of the hand. Both soon unite, and become inserted by a thin tendon into the base of the first phalanx of the index finger, where its fibres also unite with those of the extensor tendon. *b.* The *second* dorsal interosseous muscle lies in the second metacarpal space. It arises from both bones, and is inserted tendinous into the radial border of the extensor tendon, covering the first phalanx of the middle finger. *c.* The *third*, similarly placed in the third metacarpal space, is inserted into the

opposite or ulnar border of the tendinous expansion of the extensor communis, that covers the middle finger. *d.* The *fourth*, lying in the corresponding space, is inserted into the ulnar side of the ring finger, by becoming attached to the tendinous expansion that covers it.

417. The palmar interossei lie rather on the palmar surface of the bones than in their intervals. They are three in number, and are undivided at their origin. *a.* The *first palmar* interosseous muscle arises along the ulnar border of the second metacarpal bone, and is inserted at the same side of the base of the first phalanx of the index finger, where the fibres of its tendon are blended with those of the extensor communis. *b.* The *second* arises from the radial border of the fourth metacarpal bone, and is inserted into the base of the first phalanx of the ring finger, by its radial border. *c.* The *third* arises from the radial side of the fifth metacarpal bone, and is inserted into the base of the first phalanx of the little finger, by its outer or radial border.

Thus the index and ring fingers have each two interossei muscles (one palmar, and one dorsal); the middle finger has two of the dorsal set, and the little finger has one of the palmar.

Actions.—All the interossei muscles act on the first phalanges of the fingers. They obviously possess the power of adduction and abduction, according to the manner of their insertion, and so can make the fingers diverge from, or approach to one another. The dorsal set may, to a certain extent, assist the extensor communis, in extending or drawing back the fingers; and again, if the fingers be but slightly bent, as the direction of the interossei in that position forms an angle with that of the phalanges, they may assist in drawing them to the palm of the hand, that is, in flexing them.

SECTION II.

THE ARTERIES OF THE UPPER EXTREMITY.

418. The arterial trunk, which supplies the upper extremity, continues undivided from its commencement, as far as the bend of the elbow; but, like that of the lower extremity, different parts of it have received different names, according to the regions in which they are seated. Whilst in relation with the clavicle, which comprises all that part of the vessel intercepted between its commencement and the lower border of the first rib, it is called *subclavian;* from the point just indicated, to the border of the axilla, it is named *axillary*, and from thence to the bend of the elbow *brachial.* This mode of division is analogous to that of the inferior arterial trunk into iliac, femoral, and popliteal, and the analogy is completed by the fact, that as the one ultimately divides into the tibial and fibular branches, so does the other into ulnar and radial. As the subclavian artery commences on the left side, at the arch of the aorta, and on the right, at the division of the innominata, opposite the sterno-clavicular articulation, the vessels of opposite sides must differ materially in length and relations to contiguous parts in the first part of their course. They both agree, however, in arching upwards and outwards across the lower part of the neck, and in descending beneath the clavicle and subclavius muscle, after which they assume the name of axillary. We shall commence the description of the arteries of the upper extremity with that of the vessel last named, and shall reserve, until we have examined the cervical region, any further mention of the subclavian artery.

419. The *axillary artery* (*arteria axillaris*) lies obliquely across the superior and lateral part of the thorax, extending from the lower border of the first rib, as far as the inferior margin of the tendon of the latissimus dorsi and teres

major.* In this short course, the direction of the vessel is outwards, downwards, and a little backwards, so that when the arm hangs freely by the side, it describes a curve, whose convexity looks towards the acromion, and concavity towards the chest. It is accompanied by the axillary vein and brachial plexus of nerves, which lie at different sides of it; hence, in order that we may state precisely the relation of these vessels, as well as of the muscles to the artery, it becomes necessary to consider it, not as a cylindrical tube, but as if it were compressed so as to present four sides. The acromial side at first corresponds with a small cellular interval that separates it from the plexus of nerves, then with the divisions of the plexus, which are in close contact with it, and lower down, with the tendon of the subscapular muscle, and finally, at its termination, with the coraco-brachialis, which is interposed between it and the humerus. The thoracic side of the vessel rests on the first intercostal space, then on the first digitation of the serratus magnus. When it passes off the chest into the axillary space, it lies in the cellular interval between the serratus and subscapularis, and becomes supported by the nerves which here surround the vessel. The anterior surface is covered by the pectoralis major and costo-coracoïd ligament, or membrane, in the space between the subclavius and pectoralis minor, then by the latter and pectoralis major together, and finally, by the last-named muscle, which covers it to its termination. Its posterior surface is supported by some cellular membrane, and the deep divisions of the brachial plexus. The vein, at first separated from the artery by the insertion of the scalenus anticus muscle, lies anterior and internal to it, that is to say, to its thoracic side; lower down it comes in front of the artery, and conceals it from view, when we look into the axillary space. The space here referred to, when cleared of the cellular tissue and glands that fill it, the arm being removed from the side, is of a pyramidal form, the summit being at the interval between the scaleni muscles, and the base at the borders of the pectoralis and latissimus dorsi, its sides being formed as follows:—viz. by the pectoral muscles in front, by the latissimus and teres behind, the serratus magnus internally, and the subscapularis and head of the humerus externally. The axillary artery gives off seven branches, which are named as follows; premising, at the same time, that considerable variety obtains in their mode of origin.

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* *Boyer, Traité d'Anatomie*, tom. iii.

a. The *thoracica suprema* arises above the border of the pectoralis minor, and sometimes is derived from the thoracica acromialis, being a very small branch. It inclines forwards and inwards, getting between the pectoral muscles, to which its ramifications are distributed; some of them also go to anastomose with those of the internal mammary and intercostal arteries.

b. The *thoracica acromialis* arises from the fore part of the axillary artery, being rather a large branch. It projects forwards at the upper border of the pectoralis minor, and soon divides into branches that take opposite directions. One set inclines inwards to the thorax, the other outwards to the acromion, whence the vessel derives its name. The thoracic branches are three or four in number, and are distributed to the serratus magnus and pectoral muscles, their extreme terminations communicating with those of the other thoracic branches, as well as with the intercostal branches of the internal mammary artery. The acromial branches incline outwards, and subdivide into a descending and transverse set. The latter proceed towards the acromion, and are distributed partly to the deltoïd muscle, whilst others, upon the upper surface of that process, maintain an anastomosis with the supra-scapular and posterior circumflex arteries. The descending branch passes down in the interval between the pectoralis major and deltoid, and ramifies in both.

c. The *thoracica alaris* is very variable in size, and altogether unimportant; it is merely distributed to the glands and cellular tissue in the axilla.

d. The *thoracica longa* passes downwards and inwards along the lower border of the pectoralis minor, and is distributed to the mamma, serratus, and pectoral muscles, and anastomoses with the intercostal branches.

f. The *subscapular* branch is of considerable size. It arises from the axillary artery, close by the lower border of the subscapularis muscle, along which it proceeds downwards and backwards, soon becoming considerably diminished in size, owing to its giving off a large branch to the dorsum of the scapula. The continuation of the vessel proceeds down towards the inferior angle of the scapula, accompanied by the subscapular nerve, and lying on the muscle of that name, to which it gives branches, as well as to the serratus magnus and latissimus muscles. Its final ramifications anastomose with those of the posterior scapular artery, and with its own dorsal branch. The branch just named (*ramus dorsalis*) passes backwards from the subscapular artery, about an inch and a half from its origin, and is larger than the continuation of the vessel. Turning round the lower border of the scapula, the dorsal branch passes first through the interval between the subscapularis and latissimus dorsi, and then between the teres major and minor, and may be always found in the fissure between the last-named muscles, immediately behind the long head of the triceps. The artery gives branches to these muscles, and on reaching the dorsum of the scapula, ramifies extensively upon it, supplying the infra-spinatus muscle, and anastomosing with the supra-scapular and posterior-scapular arteries.

g. The *posterior circumflex artery* is not so large as the subscapular, near which it arises. It passes backwards immediately after its origin, winds round the shaft of the humerus, lying between the bone and the long head of the triceps, and terminates by ramifying in the deltoïd, and on the shoulder joint, having previously communicated by branches with the anterior circumflex, and supra-scapular arteries.

h. The *anterior circumflex artery* is much smaller than the preceding, and varies very much in its mode of origin, as it is observed to come either from the subscapular, the posterior scapular, or the axillary. It passes from within outwards and forwards, between the coraco-brachialis and inner head of the biceps, and the fore part of the humerus, until it reaches the bicipital groove. There it divides into two branches, or in some cases, into two sets of branches; of these one ascends by the long head of the biceps through the groove in which it runs, and is distributed to the head of the bone and the capsule of the joint; the other continues outwards, in the original direction of the vessel, and after anastomosing with the posterior scapular branch is lost in the deltoïd.

420. The *brachial artery* (*arteria brachialis vel humeraria*) is placed along the internal and anterior aspect of the arm, extending from the lower border of the axilla, to about a finger's breadth below the bend of the elbow. Its direction is downwards, outwards, and forwards, and may be marked out by a line drawn from midway between the borders of the axilla to the middle point between the condyles of the humerus. If the arm be allowed to hang freely by the side, the course of the vessel is indicated by the seam in the coat sleeve. The artery is accompanied by the median nerve, the basilic vein, and venæ comites. In the upper part of its course, it rests on the triceps muscle, the spiral nerve, however, and the profunda artery intervening; in the middle of the arm, it crosses over the insertion of the coraco-brachialis, and lies from thence to its termination on the brachialis anticus. The artery may be said to be superficial in its whole course, inasmuch as it can be exposed without dividing any muscular fibres, being covered merely by the skin and fascia. Its external side is in apposition, in the upper half of the arm, with the coraco-brachialis, in the lower with the biceps, the border of which muscles somewhat overlap it. The median nerve, though its two roots embrace the axillary artery, lies at first to the acromial side of the brachial; as it descends, it inclines in front of the vessel, crossing it about the middle of the arm, so that at the elbow it lies to the inner side of the artery, and on the same plane, both being supported by the brachialis anticus. The nerve usually crosses in

front of the artery, but in some instances behind it. The venæ comites run parallel with the artery, and in close contact with it; they moreover send several short branches of communication, which pass from one to the other so as to encircle it. The internal cutaneous nerve is superficial to the artery, but it does not lie exactly in front of it; for, at the elbow, the nerve is to its inner side, and maintains a similar relation higher up. At the bend of the arm the artery sinks deeply into an angular interval, inclosed between the pronator teres and supinator radii longus. In this situation the vessel is covered by the fascia of the arm, and crossed by the process sent from the tendon of the biceps to that membrane; it rests on the brachialis anticus muscle, having the tendon of the biceps on the radial, the median nerve on the ulnar side, and finally, opposite the insertion of the brachialis anticus, divides into the radial and ulnar arteries. The position of the artery with regard to the shaft of the humerus deserves particular attention. Superiorly it is parallel with, and to the inner side of the bone, and inferiorly lies directly in front of it. In the former situation, therefore, in order to compress the vessel, the pressure must be directed from within outwards; in the latter, from before backwards: and at the intermediate point the direction of the pressure must be, as it were, intermediate too, that is to say, backwards and outwards. The brachial artery in its course gives numerous branches to the muscles by which it passes; none but the following have received names, or require description.

1. The *profunda superior* having started from the back part of the artery, just below the border of the teres major, inclines downwards and outwards, to reach the interval between the second and third heads of the triceps. In this course, it is accompanied by the musculo-spiral nerve, and both, continuing the same oblique direction, pass between the bone and the second head of the muscle, to reach its anterior and external aspect. In this situa-

tion, the artery lies deeply in the fissure, between the brachialis anticus and supinator longus, considerably diminished in size, by having given off several branches, and descends to the elbow, where it anastomoses with the recurrent radial branch. The only off-set from the profunda artery that requires a special notice, is one that descends perpendicularly from it, when lying behind the middle of the humerus, and proceeds between the triceps and the bone to the back part of the elbow joint, where it anastomoses with the interosseous recurrent branch.

The *inferior profunda branch* is smaller than the preceding, and arises from the brachial artery, about the middle of the arm. Its direction is downwards and inwards, from the point just indicated, to the back part of the inner condyle of the humerus, to gain which, it, in the first place, must pierce the inter-muscular ligament or septum, and then lie on the inner surface of the triceps (its third head,) to which it gives branches. In this course the artery lies parallel, and on the same plane, with the ulnar nerve, and enters the interval, between the olecranon and inner condyle, where it terminates by anastomosing with the posterior recurrent branch, from the ulnar artery. On a level with the preceding, or a little higher, a small branch arises, (*arteria nutritia humeri*) which runs through the fibres of the coraco-brachialis, and enters the oblique canal in the humerus, to be ultimately distributed to the medullary membrane.

The *ramus anastomoticus* arises from the brachial artery, about two inches above the bend of the arm, and is much smaller than the preceding. Resting on the brachialis anticus, this branch descends towards the inner condyle, and divides into two sets of ramifications. Of these, one lies in front of the articulation, and after supplying the brachialis anticus and pronator teres muscles, anastomoses with the anterior ulnar recurrent, whilst the other passes backwards, comes into relation with the ulnar nerve, and communicates with the posterior ulnar recurrent and inferior profunda branches.

It must be obvious, that the terms applied to the branches of the brachial artery are rather ill chosen. The inferior profunda lies beneath the fascia, and is superficial, rather than deep-seated; and the property of anastomosis is common to all, as well as the insignificant ramusculus, called anastomoticus magnus or major. The first branch may, with propriety, be named "profunda," from its situation, or "spiral," from its direction; and the two others "collateral," from their relation to the artery itself; so they were named formerly by Winslow, and still by Boyer.

421. The description above given of the course, relations, and mode of division of the brachial artery, is strictly conformable with what obtains in the greatest number of instances. Some varieties however occur which deserve notice. The vessel not unfrequently divides as high as the middle of the arm, or even higher, or rather gives off one of its two leading branches, which most commonly is the radial. On this subject, Meckel states, as the result of his observations, that when the radial artery arises in the arm, it usually commences towards the middle point, but that the anomalous division of the ulnar, though less frequent in its occurrence, takes place in most instances higher up, even as high as the point at which the axillary terminates in the brachial. A variety not hitherto noticed by any writer, (so far at least as the author is acquainted with their works) lately presented itself in the dissecting-room in Aldersgate Street. It was at first taken for the ordinary high division of the ulnar artery. The two vessels descended from the point of division at the border of the axilla, and lay parallel with one another in their course through the arm, but instead of diverging, as is usual, at the bend of the elbow, they converged and united so as to form a short trunk, which soon divided again into the radial and ulnar arteries in the regular way. If such a conformation existed in a case that required the ligature of the brachial artery, for an aneurism at the bend of the arm, it would embarrass the operator in no small degree. A similar variety in the course of the femoral artery occurred in the practice of Mr. Charles Bell.*

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* *Hunterian Lectures at the College of Surgeons.*

The brachial artery, when arrived opposite the insertion of the brachialis muscle, divides into its ulnar and radial branches.

422. The *ulnar artery* inclines in rather a curved direction downwards and inwards, passing under cover of the superficial muscles that arise from the inner condyle, viz. the pronator teres, flexor carpi radialis, palmaris longus, and flexor sublimis, until it reaches the flexor carpi ulnaris. About the same point, that is, at the junction of the upper with the middle third of the fore-arm, the artery comes into contact with the ulnar nerve, which had previously been separated from it by a considerable interval, having lain behind the inner condyle, but here approaches it, lying to its ulnar side. Thus placed, they both descend towards the inner border of the palm of the hand. In the first part of its course, the artery is covered by the muscles above enumerated; in the middle of the arm, it is overlapped by the flexor ulnaris, and, in the lower, runs parallel with its tendon, covered only by the fascia and skin. For two-thirds of its extent it lies on the flexor profundus, in the rest, on the pronator quadratus, and annular ligament. It is accompanied by two veins, which lie one on each side, in its entire extent, and by the ulnar nerve lying to its ulnar border, for the lower two-thirds of its course.

423. The ulnar artery, guided as it were by the tendon of the flexor ulnaris muscle, reaches the radial or palmar border of the pisiform bone, where, accompanied by the nerve, it passes over the cutaneous surface of the annular ligament of the wrist. At this point the artery begins at once to change its direction, by running outwards and forwards, across the palm of the hand, and on arriving about midway between the flexure formed by the bend of the first joint of the thumb, and that of the fore-finger, it terminates by inosculating with a branch (*superficialis volæ*) sent forwards by the radial artery, to unite with it. The vessel thus describes a curve, whose convexity looks for-

wards. This curved part of the artery is called the *superficial palmar arch*, to distinguish it from the deep-seated one, formed by the radial artery. It rests on the annular ligament at its commencement, and afterwards on the tendons of the flexor sublimis; and is covered, for a short way, by the palmaris brevis, and afterwards by the palmar fascia and integument. The vessel, in the palm, is usually somewhat tortuous; and presents some varieties in its course and mode of termination; which are, however, of little importance in a practical point of view. The branches of the ulnar artery are as follows:

a. The *anterior recurrent* branch arches inwards from the ulnar artery about an inch below its origin, running on the brachialis anticus, and covered by the pronator teres, to both of which it sends ramusculi. On reaching the inner condyle, it anastomoses with the ramus anastomoticus and inferior profunda, from the brachial artery.

b. The *posterior recurrent* branch not unfrequently arises by a small trunk common to it and the preceding. It runs backwards somewhat, and ascends upon the posterior aspect of the inner condyle, and in the interval between that process and the olecranon, anastomoses with the inferior profunda, some of its branches extending outwards, so as to communicate with those of the superior profunda, and interosseous recurrent.

c. The *interosseous* artery is of considerable size, and is sometimes called the common interosseous artery, from the circumstance of its dividing into two vessels bearing that name, which lie on the opposite surfaces of the interosseous ligament or membrane. This vessel inclines somewhat backwards after its origin, to reach the upper border of the interosseous ligament, where its division takes place. The *anterior interosseous* branch proceeds downwards, lying on the anterior surface of the membrane of the same name, and is accompanied by the interosseous branch from the median nerve, and overlapped by the contiguous borders of the flexor profundus, and flexor longus pollicis. Thus placed, it reaches the upper border of the pronator quadratus muscle, where it passes from before backwards, through an opening in the interosseous membrane; and, on reaching its dorsal surface, proceeds along the back of the carpus and hand, ramifying freely on both, and maintaining communications with the branches of the radial, and posterior interosseous arteries. The *posterior interosseous* branch passes backwards, through the interval left between the oblique ligament, and upper border of the interosseous membrane, (sect. 134). Continuing its course downwards, along the arm, under cover of the extensor muscles, it gives several branches to them, and reaches the carpus, considerably diminished in size, where its terminal branches anastomose with those of the anterior interosseous artery, and with the carpal branches of the radial and ulnar arteries. In addition to numerous muscular and communicating branches, which require no special notice, this artery gives off the *posterior interosseous recurrent* branch, which is nearly as large as the continuation of the vessel. The recurrent branch passes directly upwards, covered by the supinator brevis and anconeus, in the interval between the olecranon and external condyle, where it divides into several ramusculi, that anastomose with the terminal branches of the profunda superior and inferior, as well as of the posterior ulnar recurrent.

d. Several branches are distributed to the muscles in its course along the arm.

e. *Carpal* branches (anterior and posterior) run upon the corresponding surfaces of the carpus, and communicate with similar branches from the radial and interosseous arteries.

f. A *communicating* branch passes backwards, between the flexor brevis and abductor of the little finger, and becomes continuous with the termination of the deep palmar arch formed by the radial.

g. *Digital* branches, four in number, proceed forwards from the convexity of the palmar arch, to supply the fingers. The *first* branch inclines inwards, to the ulnar border of the hand, and after giving ramusculi to the small muscles of the little finger, runs along the inner margin of its phalanges. The *second* runs along the fourth metacarpal space, and at the root of the fingers divides into two ramusculi, which proceed along the contiguous borders of the ring and little fingers. The *third* is similarly disposed of to the ring and middle fingers, and the *fourth* to the latter and the index. Each pair of collateral branches, on arriving at the base of the last phalanx of the finger, converge and form an arch from the convexity of which, small ramusculi run forwards to its termination. From the concavity and dorsal surface of the arch small branches are given to the parts in the palm of the hand.

424. The *radial artery*, in direction, though not in size, appears to be the continuation of the brachial. It runs directly from the point of division above indicated, to the head of the radius, lying along the anterior and external side of the fore-arm, its course being indicated by a line drawn from the middle of the bend of the elbow, to the narrow interval between the trapezium bone and the tendons of the two first extensors of the thumb. These can be readily felt towards the outer border of the wrist. The artery at first is supported by the branches of the musculo-spiral nerve, and some cellular tissue, which separate it from the supinator radii brevis muscle; it then passes over the insertion of the pronator teres, and the radial origin of the flexor sublimis: after which, it lies on the flexor pollicis longus and pronator quadratus, until it reaches the end of the radius. Its anterior surface is covered by the fascia of the arm and integument, and for some way is overlapped by the fleshy part of the supinator longus, which must be turned aside, in order to expose it. To its inner sides lies the pronator teres in the upper part of its course, and the flexor carpi radialis in the rest; its outer side being in apposition with the supinator longus all the way down. Two venæ comites run parallel with the artery; and the radial branch of the spiral nerve lies to its radial side during the middle third of its extent; but above that part the nerve is separated from it by a considerable interval, and lower down it turns backwards, to reach the dorsal aspect of the arm, and loses all anatomical relation to it. Opposite the end of the radius the artery inclines outwards, passing between its styloïd process and the trapezium, and

beneath the two first extensors of the thumb. It then runs forwards for a short way (lying in the angular interval between the tendons of the two first extensors of the thumb, and that of the third) to gain the angle between the two first metacarpal bones, and makes its final turn into the palm of the hand, by passing between the heads of the abductor indicis muscle. The terminal part of the artery (*arcus volaris profundus*) runs transversely across the palm of the hand, lying on the heads of the interossei muscles, and the carpal extremities of the metacarpal bones of the fingers, and opposite the fourth bone of that name ceases, by inosculating with the communicating branch from the ulnar, which completes the deep palmar arch. This differs from the superficial arch, not only in being more deeply seated (being covered by all the flexor tendons and the lumbricales) but also in retaining its size almost undiminished, and lying nearer the carpus. The radial artery gives off the following branches:

a. The *recurrent branch* arches upwards from the artery soon after its origin, running between the branches of the spiral nerve. It lies on the supinator brevis, covered by the supinator longus, and opposite the external condyle anastomoses with the terminal branches of the superior profunda, having in its course given ramusculi to the flexor and supinator muscles.

b. Several un-named branches are given to the muscles on the fore part of the arm.

c. The *superficialis volæ* proceeds directly forwards from the artery, where it turns towards the back of the hand, and seems like the proper continuation of that vessel in direction, though not in size, as it is usually small and tapering. In this respect, however, it is subject to many varieties. This branch runs over the small muscles of the thumb at their origin, lying upon the annular ligament, to which it is bound down by a thin process of fascia, and terminates by inosculating with the radial extremity of the superficial palmar arch, which it thus completes.

d. The *dorsal branches of the thumb* (*rami dorsales pollicis*) are two, which sometimes arise separately, at others, by a common trunk, which divides into two ramusculi, that run along, upon the dorsal aspect of the bones of the thumb, one at its radial, the other at its ulnar border.

e. The *dorsal branch of the carpus* (*dorsalis carpi radialis*) arises close by the tendons of the radial extensor muscles, beneath which it runs upon the dorsal surface of the carpus, to anastomose with a similar branch, proceeding from the ulnar artery. From the concavity of the arch thus formed, ramusculi proceed backwards, and communicate with the interosseous arteries, and from its convexity others run forwards along the metacarpal spaces, supplying the dorsal interosseous muscles, and anastomosing with the digital arteries. A small branch will be found also on the anterior surface of the carpus, arising from the radial artery somewhat higher up. It is called *ramus anterior carpi radialis,* to distinguish it from a similar branch from the ulnar, with which it anastomoses.

f. The *dorsal branch of the index finger* (*dorsalis indicis*) arises lower down than the preceding, and after sending ramusculi to the abductor indicis, ramifies on the dorsal surface of the index finger. Its size is very inconsiderable.

g. The *ramus princeps pollicis* commences where the artery is about to turn into the palm of the hand, and after proceeding forwards, between the abductor indicis and adductor pollicis, divides near the extremity of the first metacarpal bone, into two ramusculi, which run along the borders of the phalanges of the thumb at its palmar aspect. These form its collateral branches, and unite by anastomosing upon its second phalanx, in the same way as those of the other fingers, derived from the superficial palmar arch.

h. Close to the preceding, a branch arises variable in size, but very regular in its course, called *ramus radialis indicis.* It runs along the external border of the index finger, and on its last phalanx anastomoses with the corresponding collateral branch, derived from the superficial palmar arch.

SECTION III.

THE VEINS OF THE UPPER EXTREMITIES.

425. The veins of the upper extremity are divisible into two sets, one being superficial, the other deep-seated.

The latter accompany the arteries, whose course has been described in the preceding section, commencing at their digital extremities. The incipient ramusculi unite into branches of larger size, which are observed to lie in pairs at each side of the radial and ulnar arteries, and, at the bend of the elbow, these two pairs converge, and form a pair, bearing a similar relation to the brachial artery in its entire course, and hence named *venæ comites vel satellites*. These finally merge in the axillary vein. The superficial veins are much larger, and lie between the skin and fascia. They commence on the dorsal surface of the fingers, and as they converge and communicate with one another on the back of the hand, they form a sort of venous plexus, from which issue two chief veins, that take, one the radial, the other the ulnar border of the fore-arm.

426. The *radial cutaneous veins* commence by ramusculi placed on the dorsal surface of the thumb and fore-finger. These ascend upon the outer border of the wrist, and form by their union a pretty large vessel, which passes along the radial border of the fore-arm, receiving numerous branches from its anterior and posterior surfaces. At the bend of the arm it receives a division of the median vein, and there changes its name, being in the rest of its course called the *cephalic vein*. The cephalic vein ascends along the external border of the biceps muscle, and then in the interval between the pectoralis major and deltoïd, and finally terminates in the axillary vein, between the coracoïd process and the clavicle.

427. There are two *ulnar cutaneous veins*, one on the anterior, the other on the posterior surface of the fore-arm. The posterior one begins on the back of the hand by some ramusculi, which unite to form a vein placed over the fourth metacarpal space, and called by some of the older anatomists "salvatella." This proceeds along the ulnar border of the fore-arm, at its posterior aspect, and somewhat below the bend of the elbow, turns forwards to join

with the anterior ulnar cutaneous vein. The vein last named commences upon the anterior surface of the wrist, and thence ascends along the fore-arm, communicating by branches with the median vein on the one hand, and the posterior ulnar cutaneous on the other. At the bend of the elbow it unites with the posterior ulnar cutaneous vein, and also with the median basilic, so as to form a trunk called the *median basilic vein*. This is usually of considerable size; it ascends along the inner side of the fore-arm, and finally terminates in the axillary vein, or in one of the venæ comites of the brachial artery.

428. The *median vein* results from the union, on the anterior part of the fore-arm, of several branches. It is a short trunk, which serves as a means of communication between the ulnar and radial veins on each side, as well as between the superficial and deep veins of the arm. Its length is subject to many varieties, it terminates by dividing into branches, which diverge at an angle, one inclining inwards to join the basilic vein, and thence called *median basilic*, the other, outwards, to end in the cephalic vein, and named, on that account, *median cephalic*.

429. The *axillary vein*, formed by the union of the basilic vein and the venæ comites, inclines upwards and inwards, receiving, as above stated, the cephalic vein, and also small veins corresponding with the different branches of the axillary artery. It passes between the clavicle and first rib, lying on the origin of the anterior scalenus muscle, which separates it from the subclavian artery, and, opposite the sterno-clavicular articulation, unites with the internal jugular vein, to form the vena innominata. The part of the vessel intercepted between the first rib and the latter point is called the *subclavian vein*.

Section IV.

THE LYMPHATICS OF THE UPPER EXTREMITIES.

430. These vessels are divisible into two sets, one being superficial, the other deep-seated. The *deep lymphatics* follow the course of the radial, ulnar, and interosseous arteries, and of their respective branches, so that it is quite unnecessary to give any thing like a detailed description of them; they all terminate in the glands of the axilla, or by joining the superficial lymphatics.

431. The *superficial lymphatics* commence by two divisions. Of these one corresponds with the branches of the ulnar cutaneous vein, which its different ramusculi accompany from the inner border of the hand, along the fore-arm, as far as the bend of the elbow. In this course they receive numerous branches from the surrounding parts, and join at the point just indicated, with the external or posterior lymphatic vessels. The division last named, consists of the lymphatic branches which are placed along the posterior and external border of the fore-arm, following the course of the radial cutaneous veins. They ascend towards the bend of the elbow, and unite with the other set, so as to form two or three trunks, which pass along with the brachial artery, and open into the axillary glands, having previously communicated with, or received the deep lymphatics.

432. From the glands in the axilla, vessels, fewer in number, but larger in size, issue and proceed along with the subclavian artery, in some parts twining round it. From the top of the thorax they ascend into the neck, close to the subclavian vein, and having joined with the lymphatics of the head and trunk, terminate at the angle of union formed by the subclavian and internal jugular veins.

SECTION V.

THE NERVES OF THE UPPER EXTREMITIES.

433. The nerves of each upper extremity are derived from the anterior branches of the four last cervical, and first dorsal pairs of the same side. These unite in a peculiar way to form an interlacement called the *axillary* or *brachial plexus,* which extends from opposite the sixth cervical vertebra to the coracoïd process. In the neck, the branches which form it, lie between the scaleni muscles; closely aggregated together, they pass downwards and outwards into the axillary space, between the subclavius muscle and the first rib, and are placed to the acromial side of the accompanying artery. From this nervous interlacement, several nerves proceed, which may be divided into three sets. 1. The first consists of those which pass off rather high up from the plexus, viz. the supra-scapular, the sub-scapular, and the thoracic, the latter, consisting usually of three branches, all, however, going to nearly the same destination. Opposite the coracoïd process, the plexus divides into six ultimate branches, for the supply of the limb, which may be resolved into—2, those which reach the hand and fingers, consisting of the ulnar, median, and the spiral nerves; and 3, those which do not extend so far, namely, the internal cutaneous, the external cutaneous, and the circumflex nerves.

434. The branches which form this plexus are said by Boyer, and other anatomists, to interlace inextricably. An arrangement of them, however, may be made as follows: a probe may be previously passed across, through the primary divisions of the plexus, so as to divide them into an anterior and posterior set. The anterior branches of the fifth and sixth cervical nerves will be observed, after coming out of the intervertebral foramina, to unite and form a common trunk, which, after giving off the supra-scapular nerve, separates into two divisions. Of these, one,

posterior in situation, descends to form the circumflex nerve, and gives a small slip to form the spiral; the anterior division unites with a similar one from the seventh, and the common trunk thus resulting, gives at its upper side the external cutaneous nerve, at the lower, the outer head of the median. The first dorsal nerve ascends to join the last cervical, to form a common trunk, which also separates into two divisions. The posterior one unites with a similar offset from the seventh to form the spiral nerve; whilst the anterior, after giving off from its inner side the internal cutaneous nerve, divides ultimately into the ulnar and inner head of the median.

435. 1. The *supra-scapular* nerve passes off from the plexus as high up as opposite the sixth cervical vertebra. Its direction is backwards and outwards, as it descends to the superior border of the scapula. The nerve passes through the supra-scapular notch, or foramen, and so reaches the dorsum of the scapula, where it gives branches, first, to the supra-spinatus muscle, and then continues its course upon the neck of that bone, until it arrives in the infra-spinalis fossa, where it terminates by ramifying in the muscles.

436. 1. The *sub-scapular* nerves pass backwards from the plexus, at first lying deeply in the axillary space; they are usually three in number. One, the smallest of the three, enters the sub-scapular muscle, and is distributed to its substance. The others not unfrequently arise by a common trunk, but sometimes separately; both proceed in the same course as the sub-scapular artery, one supplying the muscle of that name, as well as the teres major and minor, whilst the other, somewhat larger, pierces the teres major, and ramifies in the latissimus dorsi.

437. 3. The *thoracic nerves* are usually three in number. Of these two may be observed to pass down on the fore part of the thorax, lying in front of the axillary vessels, and to terminate by ramifying in the substance of

the pectoralis major and minor muscles. Another very long branch commences by two filaments, which soon unite to form a thin, flat nerve, that lies behind the plexus, as well as the axillary vessels. It descends along the thoracic side of the axillary space, resting upon the serratus magnus muscle, to which in its course it gives branches, and finally terminates by ramifying in the lower part of that muscle. This nerve, from its situation, is called the *posterior thoracic* branch. Mr. Bell classes it amongst the respiratory nerves, as, according to his views, its function is to associate the muscle to which it is distributed with the general respiratory movements. From its situation it is named the external respiratory nerve, to distinguish it from the phrenic, which is placed within the thorax.

438. 4. The *internal cutaneous* nerve, commencing at the inferior and internal part of the plexus, descends along the inner side of the arm, being the smallest and most superficial of the nerves derived from the plexus. It lies for some way covered by the fascia of the arm, and divides at a variable distance above the elbow, into two branches, which separately pierce the fascia. One of these may be observed to cross in front of the median basilic vein, and then to descend along the fore part of the arm, gradually inclining towards its inner side. It distributes several filaments to the skin, and maintains communications with the external cutaneous nerve, on the one hand, and the larger branch, or proper continuation of the internal cutaneous on the other, and finally ceases at the wrist. The other division of the nerve is larger than the preceding, and lies nearer to the inner condyle of the humerus. At the bend of the elbow it inclines towards the ulnar border of the fore-arm, distributing filaments on each side as it descends, which freely ramify in the integument. Towards the carpus the nerve is necessarily much diminished, after having given off so many branches; its final ramifications may be traced as far as the skin over the inner border of the hand. Previ-

ously to reaching the elbow, and before its division, the nerve sends off several small and delicate branches to supply the skin that covers the biceps and triceps muscles.

439. 5. The *external cutaneous* nerve (*musculo-cutaneous, nervus perforans*) issues from the superior and external part of the plexus, being intermediate in size between the preceding nerve and the ulnar. Its direction is outwards and downwards, so as to reach the border of the coraco-brachialis muscle, the fibres of which it in most cases pierces, but sometimes passes behind it. In either case, the nerve passes between the biceps and brachialis anticus muscle, where it gives off three or four branches to the muscles between which it lies, the continuation of the nerve being intended for the skin, whence its name, *musculo-cutaneous*. After this the nerve inclines outwards as it descends, reaches the outer border of the arm, and pierces the fascia, so as to come into contact with the median cephalic vein, behind which it lies. The nerve is thus placed between the fascia and integument, at the external or radial border of the fore-arm, along which it continues to descend as far as the wrist, where it terminates by dividing into two sets of filaments, one of which ramifies on the skin covering the anterior, the other in that on the posterior aspect of the carpus. The branches given off by the nerve in its entire course, are divisible into two sets, one muscular, the other cutaneous, whence its name. The muscular branches consist of three or four filaments distributed to the flexor muscles; one may be traced for some way in the interior of the coraco-brachialis, arising from the nerve whilst passing through its substance, or beneath it; the others go to the biceps and brachialis. The cutaneous branches not only supply the integument of the fore-arm, but also maintain communications with the internal cutaneous nerve on the one hand, and the cutaneous branches of the spiral on the other, by filaments which take a curved direction, and unite with si-

milar offsets from the nerves just mentioned, so as to form arches, whose convexity, for the most part, looks down towards the hand. Finally, on the fore part of the wrist, and root of the thumb, its terminal branches unite in the same way with the cutaneous branches sent by the median nerve, to the integument on the palm of the hand.

440. 6. The *circumflex*, or *axillary* nerve, is deeply seated, and altogether concealed by the plexus. It passes outwards and backwards immediately after its origin, and soon comes into contact with the posterior circumflex artery. The nerve and artery will be observed to run together close behind the shaft of the humerus, in order to reach its external aspect, where they both turn forwards somewhat, so as to lie between the bone and the deltoïd muscle, to which the branches of both are finally distributed. The long head of the triceps lies behind the nerve in the first part of its course, and the sub-scapularis above it, the teres major being below it. To each of these, filaments are given; and where it turns beneath the deltoïd, a considerable branch descends, becoming superficial, and is distributed to the skin that covers that muscle and the triceps extensor.

441. 7. The *ulnar nerve,* intermediate in size between the external cutaneous and median nerves, is usually detached from the plexus opposite the lower border of the sub-scapular muscle. It inclines a little backwards as it descends along the arm, resting first on the long, then on the short head of the triceps, until it reaches the interval between the inner condyle of the humerus and the olecranon. There the nerve, after passing through the interval between the heads of the flexor ulnaris muscle, reaches the fore-arm, along which it descends, close to its ulnar border, resting on the flexor profundus muscle, and covered by the flexor ulnaris. Towards the lower part of the fore-arm the nerve lies close to the border of the tendon of that muscle, along which it runs to the pisiform bone and annu-

lar ligament of the wrist. Having passed in front of the latter, it divides into two branches, one being superficial, the other deep-seated. The *superficial* branch, the larger of the two, soon gives off, at its inner side, a considerable branch, which inclines towards the ulnar border of the hand, lying upon the short muscles of the little finger, to which it gives filaments. On reaching the head of the metacarpal bone, it proceeds along the inner margin of the digital phalanges to their extremity, forming the first digital or collateral branch of the fingers. Continuing its course directly forwards, the superficial branch rests on the abductor muscle of the little finger, where it gives a small offset from its radial side, which joins with the last digital branch of the ulnar nerve; and, finally, on arriving opposite the heads of the metacarpal bones (fourth and fifth) it divides into two ramusculi, which run along the contiguous borders of the ring and little fingers.

442. The *deep-seated palmar* branch of the ulnar nerve becomes concealed from view by passing beneath the adductor of the little finger. It then inclines outwards across the metacarpus, covered by the flexor tendons, and resting on the interossei, and terminates by two or three filaments, which ramify in the adductor pollicis. The deep nerve, like the corresponding artery, forms an arch, whose convexity is turned towards the fingers; and, in its course branches are given off on each side to the interossei muscles, as well as to the small muscles of the little finger.

The ulnar nerve distributes several branches, which, if taken in the order of their occurrence, will be found as follows:—*a*, at the lower border of the axilla one or two filaments are given to the teres major, and latissimus dorsi; *b*, in the arm a few branches pass into the substance of the long and short heads of the triceps muscle, on which the nerve lies; *c*, in the fore-arm numerous branches are given to the contiguous muscles, viz. the flexor carpi ulnaris, and flexor profundus, and also some filaments, which maintain communications with the branches of the median nerve; *d*, at the union of the middle with the lower third of the fore-arm, a branch of considerable size inclines backwards from the nerve, and reaches the dorsal aspect of the limb, after having passed beneath the flexor ulnaris muscle. Continuing to descend, it lies superficial to the extensor carpi ulnaris, and so reaches the back of the hand, where it sends a branch along the inner border of the fifth metacarpal bone, which gives filaments to the abductor of the little finger, and finally runs along its ulnar margin as far as the last phalanx. The continuation of the nerve corresponds in its course with the fourth metacarpal space, giving off several small filaments to the skin and parts on the back of the hand, and, on reaching the heads of the metacarpal bones, divides into two branches, which extend upon the contiguous margins of the little and ring fingers, in their entire length, forming their collateral branches. From the radial side of the nerve a branch not unfrequently is sent, which supplies also the external border of the ring finger, and the adjacent one of the middle finger. But it will sometimes be observed that this branch joins with some derived from the termination of the spiral nerve, and that from their union branches proceed to supply the contiguous borders of the ring and middle fingers.

443. 8. The *median nerve* is so called from the position it occupies in the fore-arm. It is of considerable size, and arises from the plexus by two fasciculi, or heads, which embrace the axillary artery. The artery, in this situation, is surrounded on every side by the divisions of the plexus. In front lies the median nerve, behind it are placed the circumflex and spiral, to the outer side, one of the heads of the median, together with the external cutaneous nerve, and to the inner, the second head of the median, with the internal cutaneous and ulnar nerves. The median nerve inclines outwards at first, in order to come into contact with the coraco-brachialis muscle. Towards the middle of the arm it crosses the artery, usually in front, occasionally behind it, and becomes placed at its inner side, resting on the brachi-

alis anticus. At the bend of the elbow the nerve sinks deeply into the interval between the flexor and extensor muscles, and passes between the two heads of the pronator teres, and beneath the upper border of the flexor sublimis. Continuing its course along the fore-arm, the nerve lies between the muscle last named and the flexor profundus, with which it passes beneath the annular ligament of the wrist, and so reaches the palm of the hand, where it divides into five branches.

a. The *first digital* branch proceeds outwards and forwards, lying upon the adductor and short flexor of the thumb, to both of which it gives filaments. It thus reaches the radial border of the thumb, and passes along its phalanges to their extremity.

b. The *second* branch is also intended for the thumb, being placed parallel with the preceding at its ulnar margin.

c. The *third*, larger than the preceding, sometimes forms, at its commencement, a common trunk with them. It proceeds directly forwards, giving some filaments to the abductor indicis, and, finally, runs along the radial border of the phalanges of that finger.

d. The *fourth* branch, still larger, corresponds in its course with the second metacarpal space, where it gives some ramusculi to the interosseous muscles, and, finally, divides into two collateral branches of equal size, which supply the adjacent borders of the fore and middle fingers.

e. The *fifth* digital branch lies in the third metacarpal space, where it communicates by a transverse slip with the ulnar nerve (its second digital branch). Like the fourth it divides into two branches, which are placed along the contiguous margins of the middle and ring fingers.

The branches given by the median nerve in the arm are very few, and so small as scarcely to deserve notice. But, in the fore-arm, several branches proceed to the flexor and pronator muscles, beneath which it lies, as well as to the flexor profundus, on which it is supported. The most remarkable of these is the *interosseous nerve.* This is of considerable size; immediately after its origin it passes backwards to reach the anterior surface of the interosseous ligament, where it comes into contact with the artery of the same name. In this situation the nerve is interposed between the flexor profundus and flexor pollicis longus, and so continues, as far as the upper border of the pronator quadratus muscle. Having passed under cover of the muscle just named, to which it gives some small filaments, the nerve turns backwards beneath the lower border of the interosseous ligament, and so gains the dorsal surface of the hand, where it ramifies in several filaments.

At the lower part of the fore-arm, another branch is given off, called, from its ultimate destination, the *cutaneous palmar* branch. This descends between the flexor tendons, passes in front of the annular ligament, and palmar fascia, and divides into filaments, which supply the skin at the centre of the palm of the hand.

444. 9. The *musculo-spiral nerve* (*nervus radialis,* Soëmm.; *radio-digital,* Chauss.) is, at first, the largest of those that issue from the plexus. Its direction is downwards and outwards, winding in a spiral manner round the bone, whence its name is derived. It lies in the cellular interval, between the short and middle heads of the triceps muscle, accompanied by the superior profunda, or spiral artery. But, in order to reach the external and anterior aspect of the humerus, where it finally appears, the nerve passes between the second head of the muscle, and the bone, lying in a canal formed for it by some tendinous fibres, which arch obliquely over it. The nerve, in the next place lies deeply in the interval between the brachialis anticus and supinator longus, which overlap and conceal it, until it reaches the elbow joint. There it divides into two primary branches, one being placed on the anterior and external part of the fore-arm, the other lying deeply at its posterior aspect.

The *anterior branch* resembles the continuation of the nerve in direction, though not in size. It proceeds directly downwards, guided by the supinator longus, giving several branches, usually five or six, which are distributed to the extensor and supinator muscles. In the middle third of the arm, the nerve, considerably reduced in size, comes into contact with the radial artery, and lies to its outer side for some way. It, after a while, inclines outwards, beneath the tendons of the supinator longus, to reach the external border of the fore-arm, upon which it descends, lying superficial to the extensors of the thumb. Near the carpus it divides into two, or sometimes into three branches. One of these runs along the radial border of the thumb, forming its first posterior collateral branch. Another corresponds with the first metacarpal space, and divides, for the supply of the ulnar border of the thumb, and the adjacent border of the fore-finger. The third, after having given a branch from its ulnar side, which supplies the contiguous borders of the ring and middle fingers, proceeds forwards in the second metacarpal space, and divides into two collateral branches for the supply of the index and middle fingers, (their adjacent borders). This branch of the spiral nerve will thus supply, besides the thumb, both sides of the index and middle fingers, and one side of the ring finger. In some cases both sides of the latter receive their nerves from the ulnar, and, occasionally, its radial collateral branch is derived from an interlacement formed by the ramifications of the ulnar and spiral nerve. The branches of the spiral nerve are numerous. Two or three, of considerable size, are given to the triceps, whilst the nerve is in contact with it. One of these ultimately becomes cutaneous, and is sometimes called *nervus cutaneous externus superior*. It ramifies for some way in the integument covering the external and anterior part of the arm, and even of the fore-arm, where it communicates with the branches of the proper external cutaneous nerve. Then it gives the different muscular branches above-mentioned, to the supinators and extensors on the outer border of the fore-arm, and in the same situation its deep-seated branch. This branch (*ramus profundus vel muscularis*) is larger than the continuation of the nerve. It inclines outwards as it descends, and after having passed beneath the supinator longus and the two radial extensors, pierces the substance of the supinator brevis. On arriving at the lower border of that muscle, the nerve gives off several branches, some being distributed to the long extensors of the fingers, others to those of the thumb. Finally, one rather remarkable by its size and regularity, lies in the interval between the radius and ulna, resting on the interosseous ligament, and thence called *ramus interosseus posticus,* it extends as far as the carpus, and ramifies on its posterior aspect.

445. The superior extremity, in addition to the several nerves thus derived from the brachial plexus, receives two or three small branches, which come from the second and third intercostal nerves. These pierce the external intercostal muscles, and also the serratus magnus, and then proceed outwards and backwards, to the lower border of the axilla, where they sometimes receive a filament from the internal cutaneous nerve. They then change their direction, running directly down beneath the integument covering the triceps muscle, to which they are distributed. These, from their origin and course, are called the *intercosto-humeral* nerves.

446. The *fascia of the arm*. The upper extremity is invested by a fascia, or membrane, analogous in its general formation to that of the lower, though by no means so dense or firm. If examined towards the bend of the elbow, it will be found to form a complete sheath for the arm, investing it all round. In this situation the fascia is continuous, with a similar investment of the fore-arm, which may thus be said to be prolonged downwards from it. The fascia is also connected intimately with the condyles of the humerus, and also with the ridges which extend upwards from

them by two membranous septa (*intermuscular ligaments*) prolonged from its inner surface to the bone, and separating the anterior from the posterior muscles. The one on the outer side of the arm extends up to the insertion of the deltoïd muscle, the other reaches to that of the coraco-brachialis. When traced upwards, the fascia becomes thin and weak where it covers the deltoïd, but yet it can be easily recognized as far as the spine of the scapula, into which it may be said to be inserted. Internally it is connected somewhat with the tendons of the pectoralis major and latissimus dorsi, and stretches across the folds of the axillary space, but gradually becomes thin, and degenerates into cellular substance, where it is prolonged towards the serratus magnus.

447. The *fascia of the fore-arm* is continuous all round with that of the upper-arm, but is much more dense and firm, being composed of fibres that interlace in almost every direction. Posteriorly it binds down the extensor muscles, being intimately connected with their fibres, as well as with the intermuscular septa placed between them; anteriorly it covers the two groups of muscles placed on the ulnar and radial borders of the fore-arm, being at the same time stretched across that angular interval into which the brachial vessels and biceps tendon sink, as they proceed to their destinations. In this situation it is strengthened by a process derived from that tendon. Inferiorly it may be said to terminate by becoming inserted into the annular ligaments (anterior and posterior). (Sect. 156, 157.)

The hand is also covered by a membranous investment, which on the dorsal surface is thin and weak, being prolonged to the phalanges of the fingers from the posterior annular ligament. But that in the palm is dense and firm, and called the *palmar fascia*, being analogous to the fibrous structure which sustains the muscles in the sole of the foot. The palmar fascia arises from the annular ligament, where its fibres are collected into a thick and rather narrow fasciculus. As they extend over the palm of the hand, they gradually diverge, so as to form rather a broad membrane. Its anterior border presents four processes, corresponding with the metacarpal bones of the fingers, and at their digital extremities, each divides into two thin fasciculi, which diverge to be inserted into the lateral ligaments of the first joint of the fingers, and into the heads of the metacarpal bones. The angular interval formed by the divergence of these processes, serves to transmit the flexor tendons, and the digital branches of the vessels.

Dissection of the upper extremity.—The subject being laid on its back, and the arm drawn away from the side, an incision may be made through the skin, commencing at the middle of the clavicle, and extended down to the centre of the axilla. From this another line may be drawn, downwards and inwards, along the lower border of the pectoralis major. The angular flap thus included, should then be raised from off the muscle just named, its dissection being conducted from without inwards to the fore part of the sternum, so as to expose the muscle. It may be necessary to make another incision through the skin, along the clavicle, to the sternum, from the point above indicated. The external flap of skin may then be dissected off the remainder of the pectoral muscle, and part of the deltoïd. When the external surface of the pectoralis major has been examined, it may be detached easily by drawing forwards its lower border, and inserting the scalpel between it and the costal cartilages, and cutting through its attachments to them, as well as to the sternum and clavicle, successively. The muscle may then be drawn outwards, and the fold in its tendon examined. The pectoralis minor is thus exposed, and the brachial vessels partly. The costal attachment of that muscle may be separated in the same way as the other. The axillary vessels are by these measures brought fully into view, little else remaining to be done than to remove the cellular tissue in which they are embedded.

When commencing the dissection of the arm, an incision may be made from the middle of the interval between the folds of the axilla, and thence drawn down to the middle of the space between the condyles of the humerus. This indicates the course of the brachial artery. It should barely divide the skin, care being taken not to injure the fascia. It will be found convenient to bound it below by a transverse incision; after which the skin may be cautiously raised from the fascia all round the arm. In order to expose the deltoïd, it will be necessary to make an incision through the integument, commencing at the external third of the clavicle, and extended along the acromion and spine of the scapula; after which it may be dissected off the muscle, proceeding from above downwards and outwards, until the whole flap of skin is removed. When the muscle has been examined, it may be easily detached from its origin, and reflected down on the arm, by inserting the scalpel under its posterior border, and cutting from within outwards, close along the margin of the spine of the scapula, and so successively along the acromion and clavicle. This will expose the circumflex vessels, and the external rotator muscles.

The fascia of the arm may in the next place be divided, and reflected in the same way as the integument. In doing so, care should be taken not to injure the internal cutaneous nerve. As the fascia is being reflected, the biceps muscle and the brachial artery and the nerves, except the circumflex and spiral, are brought into view. Their relative position, particularly at the head of the arm, should be attentively considered. If the arm be rotated outward, the direction of the spiral nerve and profunda can easily be traced, for some way, between the heads of the triceps. At the outer side of the arm, the nerve will be found in the deep sulcus between the brachialis anticus and supinator longus, after it has made its turn behind the humerus. The external cutaneous nerve also has to reach the external side of the arm, but it runs in front of the humerus, piercing the coraco-brachialis, and lying between the biceps and brachialis anticus. The examination of the triceps had better be conducted from below upwards, following the plan adopted in the description given of it. And, when its three heads have been carefully traced out, a longitudinal incision may be made through the substance of the muscle; after which, when the two parts are drawn back, the manner in which the fleshy fibres proceed to the bone, from its tendon or aponeurosis, will be distinctly seen.

The dissection of the fore-arm may be commenced by making an incision through the skin, from the middle of the interval, between the condyles of the humerus, to the root of the thumb; this marks out the course of the radial artery, and may be bounded by a transverse incision at each extremity. If the integument be drawn tightly forwards, the cutaneous nerves may be seen running in the cellular tissue between it and the fascia; and when once found, there can be little difficulty in tracing them in their entire extent, as they can be made to rest on the fascia, which gives them a firm support, whilst the scalpel is carried from above downwards, along their cutaneous surface. After the superficial nerves and veins have been examined, the fascia may be dissected off the muscles. The examination of the latter should be conducted in the order in which they have been described, commencing with those attached to the inner condyle. When the superficial set has been examined, consisting of the pronator teres, flexor radialis, flexor ulnaris, and flexor sublimis, their common origin may be divided, and the whole mass drawn down towards the hand, so as to expose the flexor profundus and flexor pollicis longus, as well as the median nerve and ulnar artery. The interosseous nerve and artery will at once be found between the two muscles last mentioned.

The supinator longus and radial extensors next present themselves for examination. And there can be no difficulty in distinguishing them, as the first line of the description has been so constructed as to indicate briefly the position and situation of the muscles of this and every other region of the body. The radial artery and its accompanying nerve will be found along the border of the supinator longus muscle.

The muscles on the posterior side of the fore-arm are numerous, and closely connected together, so that their dissection and arrangement are sometimes deemed difficult. An incision may, in the first place, be made from the olecranon to the middle of the back of the hand, which should be bounded at each extremity by a transverse incision. The skin having been thus divided, may be reflected off the fascia in its entire extent; and when the fascia has been examined, it may be divided in the same way as the skin, and dissected off the muscles, which will be facilitated by proceeding from below upwards, taking the different tendons as a guide to their respective muscles, until all of them are exposed, and their borders defined. When this has been effected, little difficulty will be experienced in distinguishing them from one another, if the first line of the description given of them be attended to; as it indicates the situation and direction of each, and when the name of a muscle is known, every thing relative to its anatomical characters will be found in the section which treats of it. When the long extensors which arise from the external condyle have been examined, they may be detached from their origin, and drawn outwards, so as to expose those which lie deeply between, or on the bones. The supinator brevis and anconeus, both short muscles, and oblique in the direction of their fibres, will be seen close below the elbow joint, whilst the extensors of the thumb, and the indicator, lie obliquely over the middle and lower part of the radius.

The first step in the dissection of the hand consists in exposing the palmar fascia in its entire extent. For this purpose a transverse incision may be made at the wrist, down to the annular ligament; for, as the fascia arises from it, it affords an easy guide to that membrane. The integument may then be raised, and reflected forwards to the fingers, or to either side. When the fascia has been examined, it may detached from its connexion with the annular ligament, and removed altogether, by which means the flexor tendons, the superficial arch of arteries, and the branches of the ulnar and median nerves, are brought into view. The digital prolongations of these different structures can, in the next place, be traced along the fingers by merely removing the integument. The short muscles of the thumb, and those of the little finger, may next engage attention. But it will not be necessary to add any thing to what has been already stated in the description of the muscles, as they are taken in their anatomical order, care being also taken to indicate their situation and general characters, so that no mistake can occur. Deep in the palm of the hand are situated one set of interossei muscles; these cannot be seen until the flexor tendons are all removed. The extensor tendons must be displaced, in order to expose fully the dorsal interossei.

Particular attention should be paid to the position of the superficial palmar arch of arteries, as well as to its digital and collateral branches. It is often necessary to make incisions along the fingers, and into the palm of the hand, to give exit to matter. Now it will at once be obvious, that as the collateral branches run along the borders of the fingers, an incision may, without any risk of injuring them, be made over the middle of the phalanges in their entire length. But the question arises how far may the incision be prolonged into the palm, or how may it be made so as to avoid the digital branches? The digital branches run along the metacarpal spaces, consequently an incision may be made over the middle of each metacarpal bone without hesitation; but if carried back too far, it would certainly cut across the palmar arch. The ulnar artery, it will be recollected, arches forwards and outwards across the palm of the hand, its curve commencing at the pisiform bone, and ending about midway between the first joint of the thumb and that of the fore-finger. The most anterior part of the arch will be observed to correspond with a transverse line marked in the skin of the hand; and so far incisions may be extended into the palm, along the centre of the phalanges and metacarpal bones. It may be said that, as the linear mark is effaced in the œdematous condition of the hand, induced by deep-seated inflammation, it cannot serve as a guide or limit to our incisions. Its place, however, may at once be indicated, by slightly bending the first joint of the thumb, and applying its phalanges close to the border of the hand; the fissure, or fold, at its palmar surface, will then be found to correspond with the line here alluded to, and will therefore mark the extent to which the incisions may be carried.

Operations.—The *radial artery* is very easily exposed and tied in the lower part of its course,—in the part where the pulse is usually felt, namely, where the vessel lies between the tendons of the supinator longus and flexor carpi radialis. The margin of the former serves as a guide to its situation. The length of the incision through the skin may be two inches, or a little more, after which the fascia may be divided to the same extent. When this is done, it may be found convenient, slightly to bend the hand, in order to relax the muscles, after which, a thin lamella of fascia, which binds down the artery, may be cautiously divided, so that the needle may be passed round the vessel. Higher up in the arm the incision must be fully three inches long, its direction being indicated by a line drawn from midway between the condyles of the humerus, to the head of the radius. Care should be taken when dividing the skin, to avoid the large cutaneous veins beneath it. The fascia should be divided over the border of the supinator longus; and when the belly of the muscle is drawn outwards, the situation of the artery and its accompanying nerve becomes apparent: but, before any attempt is made to pass the needle round it, the thin and deep-seated lamella of fascia must be divided. The needle may then be passed from without inwards, so as to avoid the nerve. The flexor carpi ulnaris serves as a guide to the ulnar artery, in the lower half of its course, being the only part in which it can be tied. The length of the incisions and steps of the operation are similar to those indicated for the radial artery,

The *brachial artery* may be exposed and tied in any part of its course, the border of the biceps, and coraco-brachialis serving as a guide to its situation. When the arm is drawn away from the side, and slightly everted, the hand being supinated, the seat of the operation is fairly brought into view. The first incision through the skin should be about three inches in length, along the border of the biceps muscle. This will expose the fascia, which is to be divided to the same extent. Now, if the operation be performed low down, the median nerve will be found to the inner side of the artery, if in the middle, it lies in front of the vessel, or crosses immediately behind it; whilst in the upper part of the arm, the nerve lies to the outer side of the artery. These facts should be recollected when the endeavour is being made to separate the nerve from the artery, preparatory to passing the ligature round the latter. When the arm is a little bent, the biceps muscle and the nerves become relaxed, and may readily be drawn aside, so as to facilitate the separation of the artery from the veins which accompany it, previously to passing the ligature round it.

CHAPTER VII.

SECTION I.

MUSCLES OF THE NECK AND FACE.

448. THE muscles of the neck are numerous, and at first sight appear to be rather complex in their distribution. They may be grouped into sets as follows. 1. Those placed at the lateral part of the neck being, at least comparatively, superficial, viz. the platisma myoides, and sterno-mastoideus. 2. The muscles placed in front, lying beneath the os hyoides, viz. the sterno-hyoideus, sterno-thyroideus, thyro-hyoideus, crico-thyroideus, and omo-hyoideus. 3. Those placed obliquely at the upper part of the neck, viz. the digastricus, stylo-hyoideus, stylo-glossus, stylo-pharyngeus. 4. Muscles placed towards the fore part, and above the os hyoides, viz. the mylo-hyoideus, genio-hyoideus, hyo-glossus, genio-hyo-glossus, and lingualis. 5. Those placed deeply at the side and front of the vertebral column, viz. the scaleni, rectus lateralis, rectus anticus major and minor, and the longus colli. All these are in pairs at each side.

Two muscles are placed superficially at the side of the neck.

449. The *platisma myoides* is a flat, thin plane of muscular fibres placed immediately beneath the skin of the neck. Its fibres commence in the cellular tissue, covering the upper part of the deltoïd and pectoral muscles, and thence proceed upwards and inwards, converging to the muscle of the opposite side. They pass over the margin of the inferior maxillary bone, some of them adhering to it, and are thence prolonged upon the side of the cheek as far as the angle of the mouth, where they become blended with the muscles in that situation. This part of the muscle,

from its effect on the mouth, was formerly called *risorius Santorini*. In some subjects, a few fibres may be traced higher up on the face to the zygomatici muscles, or even to the margin of the orbicularis palpebrarum. The platisma is covered by the skin, to which it is connected by cellular tissue, usually called the superficial fascia of the neck. It covers slightly the pectoralis major, and deltoïd; also the clavicle, sterno-mastoïd muscle, the sheath of the great cervical vessels, the submaxillary gland, labial artery, and external jugular vein.

450. The *sterno-cleido-mastoideus* is extended, as it were, diagonally across the side of the neck. It *arises* from the top of the sternum and inner third of the clavicle,—the attachment to the former being by a thick, rounded fasciculus, composed of tendinous fibres at its cutaneous aspect, the rest being fleshy. The clavicular origin is flat, and composed of fleshy and aponeurotic fibres, which pass perpendicularly upwards, whilst the sternal part inclines backwards as it ascends, so that both become inseparably blended, below the middle of the neck, into a thick, rounded muscle, which is finally inserted into the external surface of the mastoïd process, and for some way into the rough ridge behind it, by aponeurotic fibres. The external surface of the muscle is covered by the platisma in the greatest part of its extent, its sternal origin and its insertion are covered by the fascia and skin; part of the parotid gland overlaps it superiorly. In the middle it is crossed by the external jugular vein, and by some branches of the cervical nerves. It rests on part of the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles, on the cervical plexus of nerves and great cervical vessels, also on the digastricus and stylo-hyoideus muscles, and spinal accessory nerve, which pierces it.

Actions.—The lower part of the cutaneous muscle can exert no action of much importance in the human subject; it may be considered as a rudiment of that broad, fleshy lamella, which is placed beneath the skin in the lower animals. The upper part of the muscle may assist in depressing the angle of the mouth, and when its action is general, the skin of the neck becomes slightly creased or wrinkled. When the two sterno-mastoïd muscles act together, they bow the head forwards; but if one acts by itself, it is enabled, by the obliquity of its direction, to turn the head, and therefore the chin, to the opposite side. It has been said that this muscle can draw the head down to its own side, approximating the ear to the shoulder. But to effect this, its action must be combined with that of some other muscle, as the splenius; for then, as the latter arises from the spinous processes, whilst the former comes from the sternum, both converging to the mastoïd process, the head may, by their combined effort, be drawn down to the point intermediate between their attachments, namely, to the acromion process.

There are five muscles at the fore part of the neck, beneath the os hyoides.

451. The *sterno-hyoideus* lies at the fore part of the neck, close to the middle line, and immediately beneath the skin and fascia. It *arises* from the first bone of the sternum, (its thoracic surface) from the cartilage of the first rib, and sometimes from the head of the clavicle. It forms a flat, narrow band of muscular fibres, which ascends, in contact with its fellow, or corresponding muscle, to be inserted into the lower border of the body of the os hyoides. It lies on the succeeding muscle, which it partly conceals; one border being in contact with the corresponding muscle, the other with the superior part of the omo-hyoideus.

452. The *sterno-thyroïdeus*, broader and shorter than the preceding, behind which it lies, *arises* from the thoracic surface of the first bone of the sternum, lower down than the sterno-hyoideus, from which it ascends, diverging a little from the corresponding muscle, to be inserted into the oblique line, on the side of the ala of the thyroïd cartilage. The greater part of its anterior surface is concealed by the sternum and the preceding muscle, as well as by the

sterno-mastoïd; the posterior rests on the vena innominata, the lower part of the carotid artery, the trachea, and thyroïd gland.

453. The *thyro-hyoideus* appears like a continuation of the preceding, as it arises from the oblique line on the side of the thyroïd cartilage, and thence passes up to be inserted into the lower border of the great cornu of the os hyoides. It is concealed by the sterno-hyoid and omo-hyoid muscles, and rests on the thyro-hyoid membrane.

454. The *crico-thyroïdeus* is a remarkably short muscle, placed below the preceding, and, as its name implies, is attached to the cricoïd and thyroïd cartilages; its direction being obliquely upwards and outwards, diverging from its fellow of the opposite side. By this arrangement the crico-thyroïd membrane is left uncovered, except by the skin and fascia, where it is to be punctured in the operation of laryngotomy. This muscle is concealed by the sterno-hyoideus, and thyroïdeus.

455. The *omo-hyoideus* consists of two bellies, united at an angle. One of these lies close to the external border of the sterno-hyoideus muscle, and is covered only by the platisma and fascia, the other is deeply seated, lying behind the clavicle and sterno-mastoïd. It *arises* from the upper border of the scapula, near the supra-scapular notch, and from the ligament which crosses it. From thence the muscle, forming a narrow, flat fasciculus, inclines forwards across the root of the neck, where it suddenly changes its direction, ascending almost vertically, to be inserted into the lower border of the os hyoides, at the union of its body and cornu. The two parts of the muscle here described form an angle, where they lie behind the sterno-mastoïd, and are connected to each other by a short, flat tendon. This will be found enclosed within two lamellæ of the deep cervical fascia, and thereby connected with the cartilage of the first rib. It is by this mode of connexion that the angular position of the muscle is maintained.

Actions.—All the individuals of this group of muscles take their fixed point below, and therefore conspire in being depressors of the larynx and os hyoides, which is perceptible in these parts when they descend, as deglutition is being performed. The thyro-hyoideus is the only one of them that acts as an elevator. As a preparatory measure to swallowing, the pharynx is drawn up, so is the os hyoides; and, as a means of security, the larynx at the same moment is made to ascend, so as to be brought under cover of the epiglottis; this is effected by the contraction of the thyro-hyoideus, assisted by the stylo-pharyngeus, the latter being, in fact, inserted into the thyroïd cartilage.

Four muscles are placed obliquely at the upper part of the neck.

456. The *digastricus* muscle is placed in a curved direction across the upper part of the neck, a little below the margin of the jaw-bone. As its name implies, it consists of two fleshy bellies, united by a rounded, middle tendon, each of which parts has a separate attachment. The posterior belly arises from the digastric groove behind the mastoïd process, the anterior is inserted into a slight depression at the inside of the lower border of the jaw-bone, close to its symphysis, whilst the tendon is connected with the cornu of the os hyoides by a dense fascia, and by the fleshy fibres of the stylo-hyoideus muscle, through which the tendon passes. Now, as the side of the os hyoides is beneath both points of attachment, and nearly in the middle between them, the fleshy bellies, where they end in the tendon, must form an angle with one another, which, if stretched, the whole muscle will describe a curve. The anterior belly lies immediately under the skin, and rests on the mylo-hyoideus muscle, being in close contact with its fellow of the opposite side; the posterior is covered by the sterno-mastoïd, and crosses both carotid arteries and the jugular vein. Its upper margin bounds the submaxillary gland.

457. The *stylo-hyoideus* lies close to the posterior belly of the preceding muscle, being a little behind and beneath

it. It *arises* from the middle of the external surface of the styloïd process of the temporal bone, from which it inclines downwards and forwards, to be inserted into the great cornu of the os hyoides, near its body. Its fibres are divided into two fasciculi near its insertion, for the transmission of the tendon of the digastricus. Its upper part lies deeply, being covered by the sterno-mastoïd and digastricus muscles, and by part of the parotid gland; the middle crosses the carotid arteries; the insertion is comparatively superficial.

458. The ***stylo-glossus*** lies higher up, and is also shorter than any of the three muscles that arise from the styloïd process. Its direction is horizontally forwards between the carotid arteries. It *arises* from the styloïd process near its point, also from the stylo-maxillary ligament, and is inserted into the side of the tongue, its fibres expanding somewhat as they become blended with its substance.

459. The ***stylo-pharyngeus*** is larger and longer than the other styloïd muscles, and also more deeply seated. It *arises* from the inner surface of the styloïd process, near its root, from which it proceeds, downwards and inwards, to the side of the pharynx, where it passes under cover of the middle constrictor muscle, with which its fibres contract some connexion, but are finally prolonged to the posterior border of the thyroïd cartilage, into which they are inserted. The external surface of the muscle is, in the upper part of its extent, in contact with the other styloïd muscles, in the lower with the middle constrictor of the pharynx; the internal rests on the internal carotid artery and jugular vein; but, in the lower part of its extent, it is in contact with the mucous membrane of the pharynx.

Actions.—The stylo-hyoidei and stylo-pharyngei conspire in elevating the base of the tongue and the bag of the pharynx at the moment when deglutition is taking place, the latter tending at the same time to widen the pharynx. The peculiar mechanism of the digastric muscles enables them to contribute to the elevation of the os hyoides also. For when the two fleshy parts contract together, they come nearly into a straight line, and thereby draw up the bone just named, by means of the connexion of the middle tendon of the muscle with its cornu. As a preparatory measure, the mouth must be closed, and the lower jaw fixed, which is one of the first steps in the process of deglutition. If the os hyoides be kept down by the sterno-hyoideus, the anterior belly of the digastricus will serve to depress the lower jaw. The stylo-glossi muscles act on the margins of the tongue, and elevate them; if at the same the genio-hyo-glossi come into action, they will draw down its raphé, or middle line, and so its upper surface will be converted into a groove, fitted to convey from before backwards to the fauces, any substance required to be swallowed.

Five muscles are situated in front, and above the os hyoides.

460. The *mylo-hyoideus* is a flat, triangular muscle, placed immediately behind the anterior belly of the digastricus; its base, or broader part, being above, the apex being below. It *arises* from the mylo-hyoid ridge, along the inner surface of the lower jaw. The posterior fibres descend obliquely, to be inserted into the base of the os hyoides, the rest proceed, with different degrees of obliquity, to join at an angle with those of the corresponding muscle, forming, with them, a sort of raphé along the middle line, from the symphysis of the jaw to the os hyoides. Its external surface is covered by the digastricus and submaxillary gland; the internal conceals the genio-hyoideus, and part of the hyo-glossus and stylo-glossus, and also the gustatory nerve; its posterior border alone is free and unattached, and behind it, the duct of the submaxillary gland turns in its passage to the mouth.

461. The *genio-hyoideus* is a narrow, rounded muscle, concealed by the preceding, and lying close to the median line. It *arises* from the inside of the symphysis of the chin, and thence descends, (separated from the corresponding muscle only by a narrow, cellular interval,) to be inserted

into the anterior surface of the body of the os hyoides. This pair of muscles lies between the mylo-hyoideus and the lower, or free border of the genio-hyo-glossus.

462. The *hyo-glossus* is a flat, thin band of muscular fibres, placed at the side of the tongue. It *arises* from the great cornu of the os hyoïdes and part of its body, from which it inclines upwards and outwards, to be inserted into the side of the tongue, where its fibres expand, becoming blended with its substance. It supports the gustatory nerve, and conceals the origin of the middle constrictor of the pharynx and part of the lingual artery.

463. The *genio-hyo-glossus* is so called from its triple connexion with the chin, os hyoides, and tongue. The muscle forms a flat, triangular plane, placed vertically between the middle line of the tongue, and the os hyoides. Its inner surface is in contact with the corresponding muscle, the external being covered by those last described. It *arises* by a short, pointed tendon, from the prominent tubercle on the inside of the symphysis of the chin. To this the fleshy fibres succeed and diverge from one another, the inferior ones passing down to the os hyoides, the anterior forwards to the tip of the tongue, and all the rest proceeding with different degrees of obliquity to the under surface of the tongue, with which they are blended in its entire length from base to apex.

464. The *lingualis* is a thin, narrow band of fleshy fibres, extended along the under surface of the tongue in its entire length. It lies between the preceding muscle and the hyo-glossus; one extremity of its fibres is connected to the os hyoides, and the other prolonged to the tip of the tongue, being blended inseparably with its substance.

Actions.—The muscles that pass from the jaw-bone to the os hyoïdes are ordinarily employed in elevating the latter, and with it the base of the tongue, more particularly in deglutition. The genio-hyo-glossi, by means of their posterior and inferior fibres, can draw up the os hyoides at the same time, bringing it and the base of the tongue forwards, so as to make its apex protrude beyond the mouth. The anterior fibres will, subsequently, act in retracting the tongue within the mouth. The mylo-hyoidei may be compared to a moveable floor or bed, which closes in the inferior and anterior part of the mouth, at the same time serving to sustain the body of the tongue. The linguales resemble retractor muscles; they shorten the tongue, and draw its apex downwards, so as to make its dorsum convex.

Six muscles lie deeply at the side and front of the vertebral column.

465. The *scalenus anticus* lies deeply at the side of the neck, behind and beneath the sterno-mastoïd. It *arises* by a flat, narrow tendon, from the anterior surface of the first rib, from which its fleshy fibres ascend vertically, to be inserted into the anterior tubercles of four cervical vertebræ, from the third to the sixth inclusive. The lower part of the muscle separates the subclavian artery and vein. It is over-lapped by the sterno-mastoïd muscle, (a small part only projecting behind its outer border,) and crossed by the omo-hyoideus, with which and the clavicle it bounds an angular interval, in the area of which lie the subclavian artery and commencement of the axillary plexus.

466. The *scalenus posticus* is larger and longer than the preceding muscle, from which it is separated below, by the subclavian artery, and above, by the cervical nerves, as they issue from the inter-vertebral foramina. It *arises* from the first rib, about an inch behind the other muscle of the same name, and also from the second near its tubercle. The fleshy fibres ascend along the side of the vertebral column, and are inserted, by so many tendinous processes, into the posterior tubercles of all the cervical vertebræ except the first. The two origins of the scalenus posticus are separated at first by a cellular interval, which has given occasion to the division of the muscle into two

The Pharynx.

471. The pharynx is a musculo-membranous tube, extended from the centre of the base of the skull, to the œsophagus, with which it is continuous. It lies behind the nasal fossæ, the soft palate, the isthmus of the fauces, and the larynx, which open into it,—before the vertebral column, and between the great vessels of the neck. The posterior and lateral parts of the pharynx are loosely connected to the adjacent structures by cellular tissue, but anteriorly it presents the several apertures that lead into the nose, mouth, and larynx, and is therefore, as it were, deficient in this situation. Its structure is made up, externally, of muscular fibres, disposed in a very peculiar way, being formed into three lamellæ on each side, partially overlapping one another, and, internally, of mucous membrane, prolonged from the mouth and nares. These layers of muscle are called the constrictors of the pharynx.

472. The *inferior constrictor* arises from the external surface of the cricoïd cartilage, and from the oblique ridge on the side of the great ala of the thyroïd. From these attachments the fibres curve backwards and inwards, converging to those of the corresponding muscle of the opposite side, with which they unite along the middle line. The direction of the inferior fibres is horizontal, concealing and overlapping the commencement of the œsophagus; the rest ascend with increasing degrees of obliquity, and overlap the lower part of the middle constrictor. 2. The *middle constrictor* is smaller than the preceding; it *arises* from the side of the great cornu of the os hyoides, also from its lesser cornu, and the stylo-hyoid ligament. From these points of attachment, the fibres proceed backwards, diverging from one another, and are blended with those of the corresponding muscle along the middle line. The lower fibres incline downwards, being concealed by the inferior muscle, the middle run transversely, the rest ascend, overlap the superior

constrictor, and are prolonged by a narrow, pointed process to the basilar process of the occipital bone. 3. The *superior constrictor* is attached slightly to the side of the tongue, and to the extremity of the mylo-hyoid ridge, also to the pterygo-maxillary ligament, and the lower third of the internal pterygoïd lamella. From these different points the fibres of the muscle curve backwards, becoming blended with those of the corresponding muscle along the middle line, and are also prolonged by means of the posterior aponeurosis, to the basilar process of the occipital bone. Thus, by the peculiar mode of attachment of these muscles, the bag of the pharynx is completed on the sides, and posteriorly, and left open in front; and by the connexion of the upper constrictor with the pterygo-maxillary ligament, and of the latter with the buccinator, a continuous smooth surface is established from the commissure of the lips, along the side of the mouth and fauces. Besides these, we find in the pharynx two other pairs of muscular fasciculi, one at each side, derived from the stylo-pharyngeus, which is insinuated between the adjacent borders of the superior and middle constrictor, and which has been already described. The other lies more internally, being the palato-pharyngeus, which shall be described with the muscles of the palate. It may be observed, that as the lateral attachment of the superior constrictor is no higher than to about a third of the internal pterygoïd plate, whilst the insertion is into the basilar process, the fibres of the muscle, as they pass between these points, leave a small interval, in which the mucous membrane is uncovered.

The arteries of the pharynx are the pharyngea ascendens and descendens; its nerves are derived from the pharyngeal plexus, lying on its posterior surface, and from the glosso-pharyngeal nerve; its veins open into the internal jugular, or thyroïd veins.

Actions.—The pharynx is drawn up when deglutition is about to be performed, and at the same time dilated in opposite directions. It is widened from side to side by the stylo-pharýngei, which are farther removed from one another at their origin than at their insertion, and can thereby draw outwards the sides of the cavity; and as the os hyoides and larynx are carried forwards in their ascent, the breadth of the pharynx from before backwards is also increased, inasmuch as its fore part is drawn in the same direction, by reason of its connexion with the larynx. When the morsel of food is propelled into the pharynx, the elevator muscles relax, the bag descends, and then the fibres of its own muscular wall begin to contract, and force the mass down into the œsophagus. When we contrast the structure of the pharynx with that of the œsophagus, comparing the complex arrangement observable in the one, with the simplicity of the other, we see abundant evidence of its being intended for something more than a mere recipient and propellent of such matters as are to be conveyed to the stomach. It exerts an important influence in the modulation of the voice, being brought into action in the production of its higher tones. The description of the muscular structure of the pharynx may be given briefly as follows: it may be considered as a single muscle, consisting of two symmetrical halves, united by a raphé posteriorly along the middle line, the union extending from the basilar process to the œsophagus. The superior fibres curve downwards and outwards, to be fixed to the lower third of the internal pterygoïd plate, to the pterygo-maxillary ligament, and to the mylo-hyoid ridge and side of the tongue; the middle set of fibres, broad, and expanded posteriorly at the line of junction, converge as they proceed forwards, to be attached to the cornu of the os hyoides and the stylo-hyoid ligament, and are so disposed that part is concealed by the succeeding set, whilst others overlap the preceding muscle. The lower fibres proceed forwards in the same way, to be attached to the side of the cricoïd and thyroïd cartilages. The tube is thus shewn to be complete posteriorly and at the sides, being open in front, where it communicates with the nose, mouth, and larynx. When the pharynx is slit open, we expose the cavities just mentioned, and the apertures which lead into them, as well as the orifices of the Eustachian tubes.

The soft Palate.

473. The soft palate (*velum pendulum palati*) forms a partial and moveable curtain between the mouth and pharynx. Its upper border is straight, and attached to the margin of the palate bones, the lower is divided into two parts by a conical, depending process, called the *uvula*. From this, as from a common point of departure, two curved lines will be observed to extend on each side, one proceeding downwards and forwards, to the side of the tongue, the other backward to the pharynx, both being named, from their form, the arches of the palate. In the angular interval, left by their divergence, is lodged the *tonsil*, or *amygdala;* the anterior arch is also called the *isthmus* of the fauces, as it marks the narrowed interval between the mouth and the pharynx. The soft palate consists of five pairs of muscles, inclosed by the mucous membrane.

474. The *levator palati* is a long, flat muscle, which arises from the extremity of the petrous portion of the temporal bone, and from the cartilaginous part of the Eustachian tube. The two muscles converge, as they descend, to become blended with the other structures at the middle of the soft palate.

475. The *circumflexus*, or *tensor palati*, lies to the outside of the preceding, and presents two portions, differing in direction and relations. The muscle arises from the small fossa (*navicularis*) at the root of the internal pterygoïd plate, also from the anterior part of the cartilage of the Eustachian tube. From these points the muscle descends perpendicularly between the internal pterygoïd muscle and the osseous lamella of the same name, and ends in a tendon, which winds round the hamular process; it then expands into a broad aponeurosis, which is attached to the border of the palate process, and to the aponeurosis of the corresponding muscle.

476. The *azygos uvulæ* was so called, from its having

been supposed to be a single muscle; but there are really two thin fasciculi, separated by a slight cellular interval above, which usually unite towards the lower part. Each arises from the pointed process of the palate plate, and descends vertically, becoming blended with the other structures in the uvula.

477. The *palato-glossus*, or *constrictor isthmi faucium*, inclines from the uvula forwards and outwards to the side of the tongue, where it may be considered as inserted. It is merely covered by the mucous membrane, which it renders prominent, so as to form the anterior palate arch.

477. The *palato-pharyngeus* arches downward and backwards, so as to leave an angular interval between it and the preceding. It commences at the uvula, and descends into the pharynx, being intimately connected with its muscles, and is prolonged as far as the cornu of the thyroïd cartilage. It forms the posterior arch or pillar of the velum palati.

Actions.—When the mass of food is carried back towards the fauces, the soft palate is raised nearly to a level with the hard one, and not only serves to prevent the ingesta from passing into the nares, but also, by the contraction of its two arched muscles, assists in thrusting them down into the pharynx. The circumflex muscles stretch the palate from side to side, rendering it tense, whilst the proper elevators raise it up, and then the palato-glossi and pharyngei, taking their fixed points below, are enabled, by depressing the palate, to force down the food into the cavity ready to receive it.

479. The tongue is not only the proper organ of taste, but, by means of its great mobility, assists other parts in deglutition, in speech, in suction, &c. Its upper surface, or dorsum, is convex in its general outline, and marked along the middle by a slight groove, or raphé, which divides it into two symmetrical halves. About a quarter of an inch from its base will be observed a round hole (*foramen cœcum*), which forms a sort of reservoir for some

mucous follicles. We observe also several projecting points, or *papillæ*, differing in size and number, which may be arranged as follows:

480. 1. The *papillæ lenticulares*, which vary in number from ten to fifteen, are disposed in two lines, converging to an angle just before the foramen cœcum. They are rounded on their free surface, and resemble so many inverted cones, their summits being embedded in the substance of the tongue. 2. The *papillæ capitatæ, vel fungiformes*, are more numerous than the preceding, and also smaller. They are placed, for the most part, towards the borders and point of the tongue. They present each a rounded head, supported by a short, thin pedicle. 3. *Papillæ conicæ vel pyramidales*, are much more numerous than the others, and are diffused over the whole of the dorsum of the tongue from the lenticular papillæ to its point. They are minute and tapering. A fourth class has been recognized by some persons (*papillæ filiformes*), but they are very few, and placed close to the apex of the tongue. The papillæ of the three last classes consist of the ultimate terminations of the gustatory nerve, surrounded by a delicate vascular plexus, and supported by cellular tissue.

481. Between the arches of the soft palate, on each side, is lodged an elongated, oval structure, (*amygdala, tonsil,*) which seems to be composed of a great number of mucous follicles aggregated together into a mass, about the size of an almond, whence its name is derived. Its internal surface presents several small apertures, which lead into follicles, or cells, that secrete a mucous, and viscid fluid. It is of a reddish grey colour, and exceedingly vascular.

The Larynx.

482. The larynx, or organ of voice, is placed at the forepart of the neck, beneath the os hyoides, above the trachea, and forming that prominence called "pomum Adami." It is broad above, narrow inferiorly, its cartilaginous wall

being complete at the front and sides, but deficient posteriorly, where it communicates with the pharynx. It is made up, 1st, of five moveable pieces, viz. the cricoïd, thyroïd, and arytænoïd cartilages, with the epiglottis. 2. Of the membranes and ligaments, which connect these. 3. Of muscles which move them. 4. Of vessels and nerves, and some glandular structures.

483. The *cricoïd cartilage*, so called from its circular form (*κρικος, a circle*) surrounds the lower part of the larynx, surmounting the first ring of the trachea, (with which it forms a continuous tube,) and supporting and giving fixed points of attachment to the other cartilages of the larynx, of which it may be regarded as the fundamental part. The ring which it represents is about three times deeper behind than in front, owing to its superior border being in a manner excavated. Its external surface, behind and at the middle line, presents a perpendicular ridge, and, close at each side of it, two depressed surfaces, which give attachment to the posterior crico-arytænoïd muscles. A little farther forwards are two smooth depressions which articulate with the inferior cornua of the thyroïd cartilage, which are succeeded by two elevated lines for the origin of the crico-thyroïd muscles. The internal surface is smooth, and merely covered by the mucous membrane. The superior border, by its depressed part in front, gives attachment to a membrane (*crico-thyroïd*) which connects it with the contiguous margin of the thyroïd cartilage, also at each side to the crico-thyroïd muscles. At the points at which the depression begins are two smooth surfaces, which articulate with the bases of the arytenoïd cartilages. The lower border of the cartilage is somewhat curved and sharp: it is connected with the first ring of the trachea, and with the fleshy fibres of the commencement of the œsophagus.

484. The *arytænoïd cartilages* have been so called from some resemblance to a funnel (*αρυταινα, a funnel; ειδος, like*).

They may be compared to two triangular pyramids, resting by their bases on the posterior part of the cricoïd cartilage, and in close contact by their inner borders. The posterior surface of each is smooth and excavated, so as to lodge the arytænoïd muscle; the anterior, convex in its general outline, gives attachment to the thyro-arytænoïd muscles; the internal is flat, and in apposition with that of the corresponding cartilage. The base is smooth, and slightly hollowed, for its articulation with the cricoïd cartilage; to its anterior and external margin are attached the crico-arytænoïdeus lateralis, and to the posterior and external one, the posterior muscle of the same name. The summit becomes pointed, and surmounted by a small cartilaginous granule, or appendage, called *corniculum laryngis*.

485. The *thyroïd cartilage* (*thyroïdea, scutiformis*) surmounts the fore part of the cricoïd cartilage, and is the largest and most prominent of the pieces composing the larynx. It consists of two flat lamellæ, united along the middle line, in front, so as to form a projecting angle. Each lateral half is somewhat of a square form, its internal surface is smooth, and lined by mucous membrane; the external being marked by an oblique line, that gives attachment to muscles. The superior border is connected to the os hyoides by a membrane (*thyro-hyoid*); the inferior by a similar lamella to the cricoïd cartilage, and the posterior, rather thick and rounded, gives attachment to the fibres of the stylo-pharyngeus muscle, and is prolonged into processes or cornua. The superior, or great cornu, projects backwards, and is attached by a round fibrous cord (*thyro-hyoid ligament*) to the extremity of the great cornu of the os hyoides. The lesser cornu is somewhat thicker, and presents towards its extremity a flat smooth surface, which articulates with the side of the cricoïd cartilage. The anterior surface of the union formed of the lateral parts is prominent and subcutaneous; and will be observed to be truncated towards the upper margin, so as to

form an angular depression, into which is received the thyro-hyoid ligament; the posterior presents an angle, to which are attached the inferior extremity of the epiglottis, the thyro-arytænoïd muscles, and the *chordæ vocales*.

486. The epiglottis resembles in form a cordate leaf. It is a thin lamella of fibro-cartilage, placed between the base of the tongue and the glottis, which it covers during deglutition. It is broad, and somewhat round at its upper border, but inferiorly becomes pointed and prolonged by means of a narrow fibrous band to the angle of the thyroïd cartilage, where it is attached. The upper or lingual surface is free only in part of its extent, the rest being connected by the mucous membrane with the root of the tongue, so disposed as to form three small folds or fræna. The inferior or laryngeal surface is slightly concave from side to side, and convex from above downwards. The lateral borders are connected to the arytænoïd cartilages by two folds of the lining membrane which form the sides of the glottis.

487. These different parts are united by the following ligaments: 1, the cornicula of the thyroïd cartilage are bound to the sides of the cricoïd by scattered fibres and synovial membranes; 2, the lower border of the cricoïd cartilage is connected by a layer of membrane with the first ring of the trachea; 3, its upper border is attached by a similar membrane to the thyroïd cartilage in front, and posteriorly to the arytænoïd by synovial membranes, and some thin fibres—*crico-arytænoïd* ligaments; 4, from the upper border of the thyroïd cartilage a broad lamella (*thyro-hyoid membrane*) passes to that of the os hyoides, by which arrangement the top of the larynx is allowed to slip within the circumference of that bone when it is drawn upwards. The great cornua of the cartilage are also connected with those of the os hyoides by two round fasciculi, which are enclosed by the lateral borders of the lamella just noticed.

488. Besides these, we find on each side, extended from

the arytænoïd to the angle of the thyroïd cartilage, two bands, which, if regarded as means of connexion, may be termed the aritæno-thyroïd ligaments, and are placed one beneath the other. The inferior pair of fasciculi, more strongly marked than the others, consist of fibres stretched forwards from the anterior border of the arytænoïd cartilages, near their bases. These converge, and meet at an angle, where they are implanted into the posterior surface of the thyroïd cartilage, at the middle of its perpendicular depth. These ligaments, with the base of the cartilages to which they are attached posteriorly, bound a triangular interval, called *rima glottidis,* and are, from their connexion with the special function of the organ, called the proper *chordæ vocales.* The superior bands consist merely of a duplicature of the lining membrane; they contain no fibrous structure within them, and are therefore less tense, and farther apart than the others. They are noticed chiefly because their appearance is constant, and also because they form the upper boundaries of two oval intervals placed between them and the preceding pair, which are named the sinuses, or *ventricles of the larynx.*

489. The proper muscles of the larynx may be divided into two sets, viz. dilators and contractors of the rima glottidis. One pair of the dilators has been already described, as being seated outside, viz. the crico-thyroïdei. The others are the *crico-arytænoïdei* postici. These rest on the broadest part of the cricoïd cartilage, covering by their origin the whole of it, except the middle perpendicular line. Their fibres converge, as they proceed upward and outwards, to be inserted by a narrow process into the bases of the arytenoïd cartilages by their external borders. They are merely covered by the mucous membrane.

490. The contractors are the following:

491. The *crico-arytænoïdei laterales* are extended obliquely backwards and upwards, from the upper border of the cricoïd cartilage on each side, to the base of the arytæ-

noïd cartilage. They lie in the interval between the alæ of the thyroïd cartilage and the glottis, concealed by the lining membrane.

492. The *thyro-arytænoïdei* are placed immediately above the preceding, and are united with them at the point of insertion; they are stretched from before backwards, between the inner surface of the thyroïd cartilage at its angle, and the base of the arytænoïd cartilages, at their anterior border. They lie parallel with the rima. Some muscular fibres may also be traced from near the origin of the preceding, which ascend to the margin of the epiglottis. These are described by some anatomists as *depressores epiglottidis,* but it may be observed, that the closure of the aperture by means of the epiglottis, is effected by the ascent of the whole larynx, by which the rima is drawn, as it were, under cover of its operculum, and not by the descent of the latter upon it.

493. The *arytænoïdeus* muscle consists of oblique and transverse fibres intimately blended together, and laid upon the posterior concave surface of the arytænoïd cartilages. Albinus and Winslow, from a consideration of the difference in the direction of its fibres, divided the muscle into three, viz. two oblique, and one transverse; but as all conspire in their actions, and are inseparably connected together, most modern anatomists describe them as a single muscle. The oblique fibres pass from the base of one cartilage towards the apex of the other, crossing in the middle. The transverse fibres pass from one border to the other, and are partly covered by the oblique.

Actions.—The arytænoïdeus contracts the base or widest part of the rima, rendering it an elongated chink, and is therefore the direct antagonist of the posterior crico-arytænoïd muscles, which draw the bases of the cartilages outwards, and widen the interval between them. These cartilages are, on the contrary, drawn forwards, (and the antero-posterior extent of the aperture thereby diminished) by the lateral muscles, which pass to them from the cricoïd and thyroïd cartilages. It has been supposed that the fibres of the thyro-arytænoïd muscles are not merely stretched from before backwards, between the cartilages, but that some of them are attached at different points to the chordæ vocales, and so may act as stops on a musical string, limiting the extent of the part which vibrates at a given moment, and thereby modifying the sound.

The thyroïd Gland.

494. On the sides of the trachea and larynx is situated a soft, spongy, and exceedingly vascular mass, called the thyroïd gland, though it does not possess an excretory duct, or elaborate any appreciable secretion. It consists of two lateral lobes, whose longest diameter extends from above downwards, each being rounded and broad below, narrow and pointed above, and connected by a narrow transverse slip, placed usually in front of the second and third rings of the trachea, in some cases passing between that tube and the œsophagus. The lobes extend down to about the sixth ring, and upwards as far as the ala of the thyroïd cartilage. It receives four arteries of considerable size, and is surrounded by a thin investment of condensed cellular membrane, which gives its surface a smooth and shining appearance. It is covered by the skin, cervical fascia, the sterno-hyoïd, and sterno-thyroïd muscles, and in some instances projects laterally, so as in some degree to overlap the carotid arteries.

SECTION II.

The muscles of the head consist of those of the skull and those of the face. The former include the occipito-frontalis, and external muscles of the ear; the latter, those of the eye-lids, nose, lips, and lower jaw.

495. The *occipito-frontalis* is a flat, thin, digastric muscle, extended from the occiput to the forehead (whence its name), and placed immediately beneath the cranial integument, to which it closely adheres. It consists of two short

fleshy bellies, united by an intervening aponeurosis. The posterior, fleshy portion arises from the superior oblique ridge of the occipital bone, extending from its protuberance forwards to the mastoïd process. The fibres proceed forwards and upwards, and soon terminate, by becoming continuous with the aponeurosis. The aponeurosis consists, for the most part, of longitudinal fibres, which form a plane corresponding with the roof of the skull, over which it slides, and ends by giving attachment to the anterior fleshy part of the muscle. The fibres, of which the latter is composed, extend downwards and forwards on the frontal bone, and become blended at the root of the nose with the pyramidalis nasi, and along the orbital arch, with the orbicularis palpebrarum, and corrugator supercilii. The posterior attachment of the muscle corresponds in extent with those of the trapezius, splenius capitis, and sterno-mastoïd; the anterior with the superior margin of the orbit. The external border of the aponeurosis presents an arched margin, which overlaps that of the temporal muscle, but over the roof of the skull, the aponeurotic expansions from the two muscles are united, so as to form a continuous lamella.

The muscles of the external ear shall be described with that organ.

496. The *pyramidalis nasi* rests on the nasal bone, and appears like a prolongation of the preceding muscle, with whose fibres it is intimately connected at its origin, as well as with those of the corresponding muscle. The two pyramidal muscles diverge as they descend, leaving an angular interval between them, and each terminates in a thin fibrous lamella, that covers the side of the nose. The fleshy fibres are also connected with those of the orbicularis palpebrarum. Its chief effect seems to be that of giving a fixed point of attachment to the frontal muscle.

497. The *orbicularis palpebrarum* encircles the base, or external border of the orbit, forming a flat elliptic plane, that rests on the eye-lids, the eye-brow, and upper part of

the cheek. The fleshy fibres are attached only at the inner angle of the eye, where they arise from the orbital process of the superior maxillary bone, and from the internal angular process of the frontal, also from the upper border of a narrow tendon, which corresponds with the internal commissure of the eye-lids. This slip of tendon is attached internally to the ascending process of the superior maxilla, from which it runs outwards, and divides into two fibrous lamellæ, corresponding with the lids, and terminating in the tarsal cartilages. One surface of the tendon is subcutaneous, the other rests on the lachrymal sack, and to its borders are attached most of the fibres of the orbicularis muscle. The fibres of the orbicular muscle thus arising arch upwards and outwards in the direction of the eye-brow, and upper lid, and thence descend on the external angle of the orbit, returning to the points above stated. The external or orbital part of the muscle consists of distinct and well-marked fibres, whilst those of the tarsal or inner part are pale and thin; but all describe concentric curves, the centre of which bounds the aperture of the eye-lids. The external surface of the muscle is subcutaneous in its entire extent; the internal is intimately connected above with the corrugator supercilii, and occipito-frontalis; below, it rests on the origin of the elevator of the upper lip, and the zigomatic muscles; and internally, on part of the common elevator of the lip and nose, and the lachrymal sack.

498. The *corrugator supercilii* is a small pyramidal muscle, resting on the eye-brow, whose direction it takes, being altogether concealed by the orbicularis and occipito-frontalis. It arises from the nasal prominence of the os frontis, from which its fibres proceed outwards and a little upwards, and end at the middle of the orbital arch, by becoming blended with those of the two muscles above mentioned, lying between them and the bone.

Actions.—The corrugator muscle having its fixed point at the middle line, draws the eye-brow and lid inwards, and throws the skin into perpendicular lines or folds, as in frowning. The occipito-frontalis will, on the contrary, elevate the brow, and wrinkle the skin transversely, which actions are so frequently repeated by most persons, and so constantly by some of a particular temperament, that the skin is marked permanently by lines in the situations just referred to. The frontal muscle may also have its fixed point anteriorly, by means of its connexion with the pyramidalis nasi, so that it may draw the whole scalp alternately backwards and forwards, if both parts of it be alternately put in action. The orbicular muscle is the sphincter of the eye-lids. It closes them firmly, at the same time drawing them to the inner angle of the orbit, being its fixed point of attachment.

499. The *common elevator of the lip and nose* (*levator labii superioris alæque nasi*) lies along the side and ala of the nose, extending from the inner angle of the eye to the upper lip. It *arises* by a pointed process from the ascending process of the superior maxilla, and as it descends separates into two fasciculi, one of which, much smaller than the other, being inserted into the ala of the nose, whilst the other is prolonged to the upper lip, where it is blended with its orbicular and elevator muscles. It is subcutaneous, except at its origin, where the orbicularis palpebrarum overlaps it a little.

500. The *proper elevator of the upper lip* (*levator labii superioris*) extends from the lower border of the orbit, to the upper lip, lying close to the outer border of the preceding muscle, with which it is blended inferiorly. It *arises* immediately above the infra-orbital foramen, where its fibres are attached, partly to the superior maxilla, partly to the malar bone. Its direction is downwards and inwards, ceasing at the upper lip, where it unites with the rest of the muscular apparatus of that part. This muscle is subcutaneous, except at its origin, which is overlapped by the orbicularis palpebrarum; it partly conceals the levator anguli oris.

501. The *elevator of the angle of the mouth* (*levator an-*

guli oris; musculus caninus) lies beneath the preceding, and partly concealed by it. It *arises* immediately below the infra-orbital foramen, from the canine fossa, whence the name *caninus*, and is inserted into the angle of the mouth. It can be seen by drawing in opposite directions the levator labii superioris, and the zigomatici, which overlap it.

502. The *zigomatici* are two narrow fasciculi of muscular fibres, extended obliquely from the most prominent point of the cheek, to the angle of the mouth, one being larger and longer than the other. *a*. The *zigomaticus minor* (when it exists, which is not always the case) *arises* from the anterior and inferior part of the malar bone, and inclines downwards and forwards to terminate at the angle of the mouth. It lies along the superior border of the succeeding muscle. *b*. The *zigomaticus major* arises from the malar bone near the zigomatic suture, from which it descends, lying inferior and external to the lesser muscle of the same name, to be inserted into the angle of the mouth. These muscles are subcutaneous in their entire extent. The larger one covers, at its origin, a part of the masseter, and at its insertion, of the triangularis oris, with which, and the other muscles of the lip, its fibres are intimately blended.

503. The *compressor narium* is a thin small muscle, concealed at its origin and fleshy part, by the proper elevator of the lip, lying between the side of the nose and the common elevator. It *arises* narrow and fleshy from the canine fossa, from which its fibres proceed upwards and inwards, gradually expanding into a thin aponeurosis, which is partly blended with that of the corresponding muscle, and partly attached upon the dorsum of the nose. The direction of its fibres is transverse with regard to that of the muscle under which it lies.

504. The *depressor labii superioris alæque nasi*, is a small flat muscle, extended from the alveolar border of the

upper jaw, near the second incisor and canine teeth, to the cartilage of the ala of the nose; it lies between the mucous membrane and the muscular structure of the lip, with which its fibres are closely connected; this double connexion enables it to depress the lip as well as the nasal cartilage.

Opposed in situation and action to the elevator muscles are the following.

505. The *triangularis oris*, or *depressor anguli*, lies at the side and lower part of the face, being extended to the angle of the mouth from the lower jaw. It arises from the lower border of the inferior maxilla, and from its external surface. Its fibres pass upwards, so as to form a narrow process, which is inserted into the angle of the mouth, by becoming blended with the other muscles in that situation. It is covered by the skin and platisma myoides, and at its insertion, by the zigomaticus major, under which its fibres pass; it conceals part of the buccinator and depressor labii inferioris.

506. The *depressor labii inferioris* (*quadratus menti*) is a small square muscle, lying nearer to the symphysis of the chin than the preceding muscle, by which it is partly concealed. It *arises* from the forepart of the inferior maxilla, and thence ascends to be inserted into the lower lip, its fibres becoming blended with those of the orbicularis oris, and also having previously united with those of its fellow of the opposite side. It presents rather a peculiar appearance when dissected, owing to a quantity of yellow adipose matter being deposited in the interstices of its fibres.

507. The *levator labii inferioris* arises from the alveolar border of the lower jaw, close to the incisor teeth, and becomes blended with the orbicularis and substance of the lip. This pair of muscles occupies the interval between the two depressores. They are short and flat. The names of these muscles are sufficiently expressive of their actions.

At the side of the cheek is a pair of muscles, the buccinators, and round the margin of the mouth one, the orbicularis oris.

508. The *buccinator* is a thin flat plane of muscular fibres, occupying the interval between the jaws, and is of a quadrilateral figure, all its sides being attached. Thus, its upper and lower borders are attached to the alveolar margins of the maxillæ, from the first molar teeth, as far back as the last; the anterior is blended at the commissure of the lips with the orbicular muscle; whilst the posterior is fixed to a thin, flat fasciculus of tendinous fibres, extended from the internal pterygoïd plate, to the posterior extremity of the mylo-hyoid ridge of the lower jaw, close to the last dens molaris. This tendinous band, from its attachments, has been called the *pterygo-maxillary ligament;* one of its surfaces looks towards the mouth, and is lined by the mucous membrane: the other is separated from the ramus of the jaw by a quantity of adipose substance; the anterior border gives attachment, as has been here stated, to the buccinator muscle, and the posterior, to the superior constrictor of the pharynx. It is this connexion between the muscles just named which establishes a complete continuity of surface between the cavity of the mouth and that of the pharynx. The internal surface of the buccinator is lined throughout by the mucous membrane of the mouth; the external is separated from the masseter and zigomatici, which overlap it, by a quantity of soft adipose tissue, of a peculiar character. Opposite the second dens molaris of the upper jaw, its fibres give passage to the duct of the parotid gland.

509. The *orbicularis oris* belongs to the class of sphincter muscles, and like them is elliptic in its form, and composed of concentric fibres. It is flat and thin; its inner surface being in contact with the mucous membrane, the external with the fibres of the different muscles, which are prolonged to the margin of the mouth. One border cor-

responds with the red part of the lip, whilst the other is blended with the muscles just referred to, and which, from their situation and mode of attachment, are its direct antagonists.

Actions.—The aperture of the mouth is susceptible of considerable dilatation and contraction, the former being effected by the different muscles which converge to it, and which may be compared to retractors drawing with different degrees of obliquity, the lips, or their angles, in the direction of their respective points of attachment. The elevators are necessarily placed at the upper part of the face, the depressors in the opposite situation, and the proper retractors on each side. These are the zigomatici and the buccinators. The last-named muscles contract and compress the cheeks; this power is brought into play when any substance becomes lodged in the interval between them and the jaws. The fibres of the muscle are then elongated and pressed outwards, but when they begin to act, they form a flat plane, which is pressed inwards, and so forces the substance back into the cavity of the mouth. It is obvious that the orbicular muscle must be the direct antagonist of all those that converge to it. When describing the muscles, we may commence at the lips as a common point of departure, and trace their fibres from thence as they diverge, radiating to their respective attachments.

The muscles which move the lower jaw are the following:

510. The *masseter* occupies the interval between the zigoma and the angle of the lower jaw. It is a thick, compressed mass of tendinous and fleshy fibres, arranged so as to form two bundles, differing in size and direction. The *external*, or larger portion of the muscle, arises from the outer surface, and lower border of the malar bone, from which its fibres proceed downwards, and a little backwards, to be inserted into the lower half of the ramus of the jaw, extending as far as its angle. The *internal*, or smaller part, consists of fibres, whose direction is for the most part vertical, some inclining a little forwards. It arises by fleshy

and tendinous fibres from the lower border of the zigoma (extending as far back as its tubercle,) and is inserted into the upper half of the ramus of the jaw. The external surface of this part of the muscle is concealed, in the greater part of its extent, by the malar, or anterior portion, with which it is inseparably united; part, however, projects behind it, and is covered by the parotid gland. Its inner surface is in contact with the tendinous insertion of the temporal muscle into the coronoïd process, and with the external pterygoïd, where it lies across the sigmoïd notch, between that process and the condyle.

511. The *temporal* muscle is of considerable size, being broad, and expanded above, where it is attached to the side of the skull, and narrowed to a point below at its insertion. It *arises* from the whole of the temporal fossa, (p. 131) its fibres being implanted into all that depressed surface, included between the oblique ridge, on the parietal bone, and the crest that bounds the great ala of the sphenoïd, and extending from the external angular process of the frontal bone, to the root of the mastoïd process. The fibres, from this extensive origin, converge to a short, strong tendon, the posterior set proceeding almost horizontally forwards, those in the middle being nearly vertical, and the anterior set inclining a little backwards. The tendon passes beneath the zigoma, and is inserted into the coronoïd process of the inferior maxilla, which its fibres surround. The muscle is covered, and bound down by a remarkably dense, firm membrane, (*temporal fascia*) which is attached inferiorly to the margin of the malar bone and the zigoma, where it is separated from the muscle by some loose adipose and cellular tissue; but higher up, the fascia expands, and becomes closely connected with the muscular fibres, and finally ceases at the curved ridge bounding the temporal fossa, where its fibres are blended with those of the muscle.

512. The *internal pterygoïd* muscle is applied closely to the inner surface of the ramus of the jaw, somewhat as the masseter is to its outside. It *arises* from the pterygoïd groove, or fossa, from which it inclines downwards and outwards, to be inserted into the inner surface of the ramus of the jaw, for about an inch above its angle. The muscle is separated from the bone by the internal lateral ligament, and by the dental artery and nerve; the tensor palati rests on its inner surface, whilst placed in the pterygoïd groove.

513. The *external pterygoïd* muscle extends horizontally backwards and outwards, from the process of that name to the condyle of the lower jaw, being a thick, short, fleshy mass. It arises from the outer surface of the external pterygoïd lamella, from which its fibres proceed in the direction just indicated, to be inserted into the anterior surface of the neck of the condyle of the inferior maxilla; having a connexion also with the inter-articular cartilage. The muscle lies deeply in the zigomatic fossa, concealed by the coronoïd process of the jaw, and the insertion of the temporal muscle; but when the masseter is removed, part of it can be seen between that process and the condyle. As the pterygoïd muscles diverge to their destinations, they leave between them an angular interval, which transmits the gustatory and dental nerves, and the internal maxillary artery.

Actions.—The lower jaw is elevated by the temporal, masseter, and internal pterygoïd muscles, which conspire to this end. If the two first act together, the elevation is direct, but if the two last act, the obliquity of their direction enables them to carry the angle of the jaw a little forwards. The triturating movement is performed exclusively by the external pterygoïd muscles. If both act together, they draw the condyles, and therefore the whole jaw, directly forwards, so as to make the lower teeth project beyond the upper. But when only one acts at a given time, it draws the corresponding condyle forwards, the other remaining fixed, and so makes the symphysis of the jaw deviate to the opposite side. A similar movement can be given by the corresponding muscle, and the alternation of these horizontal motions constitutes trituration.

The Salivary Glands.

514. Three secreting organs are placed at each side in the region now under consideration, viz. the parotid, submaxillary, and sublingual glands. They differ in size and situation, but agree in being of a pale ash-colour, not unlike the cineritious substance of the brain, also in being composed of minute granules aggregated into lobules and lobes, and in secreting the salivary fluid which is conveyed into the mouth by ducts, that arise by radicles from the granular structure of each gland. The *parotid* gland, so called from its position with regard to the ear, is the largest of these. Its superficial extent is from the zigoma to a level with the angle of the jaw and mastoïd process, and from the meatus externus of the ear to the ramus of the jaw and masseter muscle, being also prolonged upon the latter by a process which accompanies its duct, and thence named *socia parotidis*. The external surface of the gland is covered by the skin, and partially by the platisma muscle, and bound down by a prolongation of the cervical fascia. Its substance projects deeply towards the base of the skull, in the interval between the ramus of the jaw and the mastoïd process. Thus one process fills up the posterior part of the glenoïd cavity, adhering to the capsule of the lower jaw; another passes behind and between the styloïd muscles; a third, covered by the ramus, rests against the pterygoïdeus internus. Through its substance pass the external carotid artery, and its accompanying vein, also the facial nerve. Considering the complexity of these relations, is it possible in the living subject to dissect out the body of the gland and its various deep-seated processes? The duct of the gland (*ductus Stenonis*) passes forwards on the masseter

muscle, and pierces the buccinator and mucous membrane of the mouth, opposite the second dens molaris of the upper jaw. Its direction across the face may be indicated by a line drawn from the lower margin of the concha to midway between the red margin of the lip and the ala of the nose.

515. The *submaxillary gland* lies behind and beneath the ramus of the jaw, resting on the mylo-hyoideus muscle, and separated from the parotid by the stylo-maxillary membrane, where it is covered by the skin and platisma, and invested by a lamella of cellular membrane. The facial artery runs in a groove on its upper surface. A process of the gland turns round the posterior border of the mylo-hyoideus muscle, lying beneath the mucous membrane. Its duct (*ductus Whartoni*) follows the same course, and is directed along the side of the genio-hyo-glossus muscle, towards the side of the frænum of the tongue, where it terminates.

516. The *sublingual gland* is much smaller than the others, and of an oval form. As its name implies, it lies beneath the tongue, close to the side of its frænum, resting against the genio-hyo-glossus muscle, supported by the mylo-hyoideus, and in close contact with the duct and deep process of the submaxillary gland. Its secretion is poured into the mouth by several minute orifices which open beneath the tongue on each side. Sometimes one or two small ducts join with that of the submaxillary gland.

Section III.

ARTERIES OF THE NECK AND FACE.

517. The arteries of the neck consist of the carotid and subclavian trunks, the latter being extended in a curved form across its lower part, the former mounting obliquely upwards. The two carotids, whilst in the neck are, as nearly as may be, similar in their course, size, and relations; but they differ in their length and mode of origin. The

vessel on the right side commences opposite the sterno-clavicular articulation, being the point at which the innominata divides into the carotid and subclavian arteries, whilst that of the left arises from the arch of the aorta, and is necessarily longer, and at first more deeply seated. We shall here describe the cervical portion of each, and the description of one will very nearly suffice for both.

518. The *common carotid* artery (*carotis communis vel primitiva*) ascends obliquely upwards and outwards, its direction coinciding with that of a line drawn from the sterno-clavicular articulation to midway between the angle of the jaw and the mastoïd process. Opposite the upper border of the thryoïd cartilage, the vessel divides into two great branches, of which one is distributed by its ramifications to the cranium and face, the other to the brain and eye; hence, from their destination, they are named the external and internal carotid arteries. The common carotid artery may be said to correspond with the vertebral column, being supported by the longus colli, and rectus anticus major. The inner side of the artery is in apposition below with the trachea, higher up with the larynx and thyroïd gland, and finally, with the pharynx. Along its external side run the jugular vein and the nervus vagus, the latter being behind and between both vessels; whilst in front, it is covered, below, by the skin and fascia, also by the sterno-mastoïd, sterno-hyoid, and sterno-thyroïd muscles, and crossed by the omo-hyoideus opposite the upper rings of the trachea. But from this point to its bifurcation, the vessel is covered only by the skin, platisma and fascia, owing to the fact that the sterno-mastoïd and omo-hyoideus, by diverging to their respective destinations, cease to cover it, and so leave it comparatively superficial. The artery will be found enclosed in a sheath, composed of condensed cellular membrane, which forms an investment common to it, the internal jugular vein, and the nervus vagus. The descendens noni nerve usually rests on the

forepart of the sheath; but in some instances, part of the arch of anastomosis formed by that nerve will be found within the sheath, lying between the artery and vein. The sympathetic nerve lies between the sheath and the rectus anticus, and the ascending thyroïd artery crosses behind it.

519. If the subject be turned on its back, the two carotids will be seen separated only by the interval between the sterno-clavicular articulations, whilst as they ascend, they diverge, but do not pass backwards, as may at first sight be supposed, from viewing the parts in this position; their greater apparent depth at the upper than at the lower part of the neck, is caused by the projection of the larynx and os hyoïdes forwards, which often protect them in attempted suicide. The only difference of relation between the vessels is at the lower part of their course, where the œsophagus lies close to the inside of the left carotid, and the thoracic duct behind it. They send off no branches, and therefore retain their size undiminished, as far as the upper border of the thyroïd cartilage, where each divides into the external and internal carotids.

520. The *external carotid* artery, smaller than the other in infancy, but of equal size in adult age, extends, from its point of division, to the neck of the condyle of the jaw, or a little lower, where it divides into the temporal and internal maxillary arteries. At first it lies before, and to the inner side of the internal carotid, but soon crosses it, inclining backwards, after which it curves somewhat as it ascends to its point of division. For a quarter of an inch after its origin, it is covered only by the skin, platisma and fascia; it is then crossed by the stylo-hyoid and digastric muscles, as well as the lingual nerve, and finally becomes embedded in the parotid gland. The stylo-glossus and stylo-pharyngeus, with the laryngeal nerve, run between it and the internal carotid artery, and support it, at least partially, until it reaches the gland. It gives off eight branches, including

the pair into which it ultimately divides, which may be arranged into sets as follow:—1. The anterior branches, consisting of the superior thyroïd, lingual, and facial. 2. The posterior set, viz. the occipital and posterior auris. 3. The internal, being the pharyngea ascendens. 4. The terminal ones, which are the temporal and internal maxillary.

521. 1. The *superior thyroïd artery* (*thyroidea descendens*) is given off close to the commencement of the external carotid, from which it inclines downwards and inwards, somewhat in a serpentine manner, to the upper border of the thyroïd cartilage. It then descends a little to reach the thyroïd gland, and divides into three branches, one of which runs transversely to anastomose with the corresponding vessel of the opposite side, whilst the others ramify freely in the substance of the gland, and communicate with the ascending thyroïd from the subclavian artery. The vessel is at first covered only by the platisma and fascia. Besides the proper thyroïd, or terminal branches, it gives off the following:

a.—An *ascending superficial* branch, which passes just below or upon the os hyoides, and forms an arch with its fellow of the opposite side, sending at the same time ramusculi to the adjacent muscles and integuments. *b.* A *descending superficial* branch passes down, and divides into several ramusculi, which supply the thyroïd muscles, the sterno-mastoïd, the platisma and integument. *c.* The *laryngeal* branch inclines inwards with the nerve of the same name, and in most instances pierces the thyro-hyoid membrane, but in some it passes through a foramen in the thyroïd cartilage. In either case, on reaching the inside of the larynx, it divides into three twigs, which take different directions for the supply of the small muscles and lining membrane of the organ.

522. 2. The *lingual artery* (*arteria lingualis*) inclines forwards and inwards to the cornu of the os hyoides, where it passes between the hyo-glossus and the middle constrictor of the pharynx. So far the direction of the vessel is horizontal, but it soon ascends almost perpendicularly,

being covered by the digastric, mylo-hyoid, and genio-hyoid muscles; and finally changes its course, to run directly forwards beneath the tongue, where it assumes the name of ranine artery. Its branches are as follows:

a.—The *hyoïd* branch takes the direction of the os hyoides, running on its upper border, and forming an arch by anastomosis with the corresponding vessel of the opposite side; it gives ramusculi to the contiguous muscles and integument. *b.* One or two branches arise where the artery is deeply seated, and incline backwards and upwards, covered by the hyo-glossus muscle. These are called *rami dorsales linguæ*, from their destination, for they supply the substance and upper part of the tongue, ramifying as far back as its root. At the anterior border of the hyo-glossus the lingual artery may be said to divide into *c*, the *Ranine* artery, which, in direction, is its proper continuation; it proceeds forwards beneath the lingualis muscle, and close to the outside of the genio-glossus, and finally, near the tip of the tongue, forms an arch, by anastomosing with the corresponding artery of the opposite side: and *d*, the *sublingual* artery, which passes between the genio-hyoideus and the sublingual gland, and after piercing the mylo-hyoideus, reaches the chin, where it ramifies by several ramusculi. In its course it supplies the sublingual gland, as well as the muscles passing from the chin and jaw to the tongue: it is sometimes larger than usual; in which case it will be found to supply the place of the *submental* branch of the facial.

523. 3. The *facial artery* (*labialis vel maxillaris externa*) extends from the carotid artery along the side of the face, towards the root of the nose. It is usually the largest of the anterior branches, and arises higher up than the lingual. It ascends in rather a winding course, so as to get deeply under cover of the jaw-bone, and then turns down, running in a groove in the upper surface of the submaxillary gland, as far as the margin of the jaw, over which it coils, to reach the side of the face. In its ascent, the artery is concealed by the platisma, the tendon of the digastricus, and the stylo-hyoideus; but where it rests on the external

surface of the jaw-bone, it is covered only by the integument and platisma, being close to the border of the masseter, where its pulsation can readily be felt. The artery thence ascends, inclining towards the angle of the mouth, being crossed by the depressor anguli oris, and the zigomatici. And finally, becoming much diminished in size, by having given off several branches, it ascends under the name of *ramus angularis* by the side of the nose, covered by the common elevator muscle, and terminates at the angle of the eye, by two or three very small ramusculi, which anastomose with the nasal branches of the ophthalmic artery. Its branches are numerous, and may conveniently be divided into two sets; the first consisting of those given off before the vessel reaches the jaw, being usually three or four, the second, of those distributed to the face, varying from five to six.

a.—*Arteria palatina inferior* ascends between the stylo-glossus and stylo-pharyngeus, reaching the pharynx, close by the border of the internal pterygoïd muscle. After having given small twigs to the tonsil, styloïd muscles, and Eustachian tube, it divides near the side of the levator palati into two ramusculi, of which one follows the course of the circumflexus palati muscle, and ramifies on the soft palati and its glands, whilst the other passes to the tonsil, supplying it, and anastomosing with the following branch.

b. — *tonsillaris* ascends by the stylo-glossus to the side of the pharynx, and terminates by dividing into several ramusculi, which are distributed to the tonsil and side of the tongue.

c.—A fasciculus of small branches passes into the substance of the submaxillary gland, whilst the artery is in contact with it; some of these are prolonged to the side of the tongue.

d. — *submentalis* departs from the artery near its turn round the jaw, and runs forwards, between the mylo-hyoideus and digastricus, close to the margin of the bone. At the symphysis of the chin, it divides (after having previously given twigs to the submaxillary gland and muscles) into two branches, one of which, more superficial than the other, passes between the depressor labii inferioris, and the skin supplying both, whilst the other lies between that muscle and the bone, sending twigs to the substance of the lip, and communicating with the following branch. The submental artery will sometimes be found of considerable size, and then it gives off the sublingual.

e.—*labialis inferior, vel superficialis,* inclines inwards, sending ramusculi to the muscles of the lower lip, and anastomosing with the coronaria inferior, with the submentalis, and the termination of the dental artery.

f. — *Coronaria labii inferioris* arises near the angle of the mouth, and takes a transverse and tortuous course upon the mucous membrane, covered by the muscles of the lip, at the middle of which it inosculates with the corresponding artery of the opposite side. Some of its ramusculi pass upwards into the orbicular and depressor muscles, others downwards to the chin, communicating with the branches that ramify there.

g. — *Coronaria labii superioris* is larger, and more tortuous than the preceding, above which it arises, taking a similar course as it proceeds inwards, across the upper lip. It passes under cover of the zigomaticus and orbicularis, and forms an arch by inosculation with the corresponding artery of the opposite side. In addition to several small twigs to the muscles of the lip, it gives two or three to the nose. One of these (*nasalis septi*) proceeds along the septum to the extremity of the nose; the other (*nasalis lateralis*) ramifies on the side of the nose, and forms a minute net-work on its ala, to which the nasal branch of the ophthalmic artery also contributes. The facial artery is the chief medium of communication between the superficial and deep branches of the external carotid, by means of its anastomoses with the infra-orbital, dental, and nasal branches. Also between the external and internal carotids, by its anastomosis with the ophthalmic artery.

524. 4. The *pharyngeal artery, (pharyngea ascendens)* lies deeply, and concealed from view, until some of the branches of the carotid artery and the stylo-pharyngeus muscle are drawn aside. It arises near the lingual artery, or even from the bifurcation of the common carotid, and is the smallest of the branches of the external carotid. It

rests on the rectus capitis anticus, close to the surface of the pharynx, and is directed towards the foramen lacerum anterius, where it divides into three or four ramusculi. We may, from a consideration of their direction, divide its branches into three sets.

1. Those which pass inwards, to the pharynx, usually three in number, corresponding with the three constrictors; the two inferior ones ramify in the muscular stricture merely; the superior branch, in addition to supplying the upper constrictor, sends delicate ramifications to the Eustachian tube, and soft palate, some of them extending even to the posterior nares.

2. The external branches consist of small twigs, which are given to the first cervical ganglion, to some of the cerebral nerves, as they issue from the skull, and to the conglobate glands of the neck. 3. The terminating branches are those which pass through the foramina, at the base of the skull; one or two of them accompany the internal jugular vein, and ramify in the dura mater. Another passes through the foramen lacerum anterius, and is similarly disposed of.

525. 5. The *occipital artery* runs a long and tortuous course deeply at the upper part of the neck and base of the skull, and finally arches up towards the vertex, ramifying beneath the pericranium. This vessel passes backwards, from the carotid, opposite either the lingual or fascial artery, and takes the direction of the posterior belly of the digastricus, to reach the interval between the atlas and mastoïd process, running in a groove behind the latter. In this course it crosses the jugular vein, and lingual nerve, the latter appearing to hook round it, and is covered by the sterno-mastoïdeus. Behind this muscle, it passes under the trachelo-mastoïd, the splenius, and complexus, where it is separated from the occipital bone by the fibres of the recti and obliqui muscles. The artery then changes its direction, and runs upwards, piercing the cranial attachment of the trapezius, and mounts beneath the integument, freely

distributing branches. In its course, the following branches are given off:

a.—Small twigs to the digastricus and stylo-hyoïdeus, and some of a larger size to the sterno-mastoïd.

b.—An auricular branch to the back part of the concha of the ear, and two or three to the splenius and trachelo-mastoïd.

c.—*Arteria princeps cervicis* is of considerable size, and sometimes as large as the continuation of the vessel. When this is the case, it descends bèneath the complexus, towards the lower part of the neck, and anastomoses freely with the cervicalis profunda of the subclavian. Some branches of this vessel pass outwards to the transverse processes of the vertebræ, communicating with the cervicalis ascendens, and the external ramifications of the vertebral artery.

d.—*A meningeal* branch, which enters the skull, through the foramen lacerum posterius, and ramifies in the dura mater, investing the cerebellum.

e.—The *superficial* or cranial branches of the occipital artery pursue rather a tortuous course, and as they proceed forwards on the skull separate into three divisions, which ramify upon it; these communicate with the branches of the corresponding artery on the one hand, with those of the posterior auris on the other, and with the temporal artery in front.

526. 6. The *auricularis posterior* is a small vessel, which arises sometimes from the occipital artery, but in most instances from the carotid, a little higher up than the latter. It ascends in the direction of the fold or angle formed by the cartilage of the ear, with the side of the head, and finally, after having passed above the mastoïd portion of the temporal bone, it divides into two sets of ramusculi, of which, one inclines forwards, to anastomose with the ramifications of the temporal artery, the other backwards, to communicate with the occipital. In its course, the following branches are given off:

a.—Some small twigs to the parotid gland and digastricus.

b.—A *stylo-mastoïd* branch, which enters the foramen of that name, and, on reaching the tympanum, divides into delicate ramusculi, which pass, some to the mastoïd cells, others to the labyrynth. One branch will constantly be found, in young subjects, to form, by uniting with a twig, that enters the fissura glasseri, a sort of *coronary* artery round the osseous ring of the meatus auditorius, from which delicate offsets pass inwards, upon the membrana tympani.

c.—One or two branches ramify on the posterior surface of the concha.

Opposite the neck of the condyle of the lower jaw, the external carotid divides into two terminating branches, one being superficial, the other deeply seated.

527. 7. The *temporal artery* is, at first, embedded in the substance of the parotid gland, where it lies in the interval between the meatus externus, and the condyle of the lower jaw. It soon turns forwards to reach the cutaneous surface of the zigoma (its posterior root), on which it may be readily compressed, being merely covered by the integument, and the prolonged part of the cervical fascia, and the thin tendon of the attrahens aurem muscle. Continuing to ascend, the artery lies beneath the skin, supported by the temporal muscle and its aponeurosis, and divides into two sets of arching branches, which ramify beneath the integument.

In its course it gives off:

a.—Some small twigs to the parotid gland.

b.—One or two to the masseter muscle (*masseterici*).

c.—*Arteria transversalis faciei* arises whilst the artery is deeply seated, and inclines upwards and forwards, through the substance of the gland, so as to get between its duct and the zigoma, resting on the masseter muscle, and accompanied by one or two transverse branches of the facial nerve. It sometimes gives off the masseteric branches, and divides into three or four ramusculi, which are distributed to the side of the face, anastomosing with the infra-orbitar and labial arteries.

d.—*Temporalis media vel profundior* dips beneath the temporal aponeurosis, and inclines forwards, between it and the muscle of the same name, sending branches into the latter, which communicate with the deep temporal branches, whilst others extend to the external angle of the eye, where they meet some ramifications of the ramus palpebralis. Soon after its origin this vessel usually gives some twigs to the meatus externus (*auriculares anteriores*).

e.—*Temporalis frontalis*, or anterior terminating branch, inclines forwards, as it ascends, and ramifies extensively over the forehead, supplying the orbicularis and occipito-frontalis muscles, and communicating with the frontal branches of the ophthalmic artery.

f.—*Temporalis posterior, vel occipitalis*, inclines back, on the side of the head, and seems to be the continuation of the trunk, its branches ramify freely both upward to the vertex, where they communicate with those of the corresponding vessel of the opposite side, and backwards, to meet those of the occipital artery.

528. 8. The *internal maxillary* artery is larger than the temporal, and follows a serpentine and complex course from its commencement to its termination, changing its direction several times. On leaving the external carotid, it inclines downwards and inwards, so as to get under cover of the ramus of the jaw, and, in the next place, proceeds inwards, between the two pterygoïd muscles. Opposite the pterygoïd process it ascends perpendicularly, passing between the two heads of the pterygoïdeus externus, and thus reaches the pterygo-maxillary fissure, where it makes its final turn, forwards becoming horizontal. Having assumed this direction, the artery, considerably diminished in size by having given off many branches, passes directly forwards, beneath the orbit, lodged in the infra-orbital canal, and finally emerges on the face, where it terminates by several small ramusculi. It will thus be observed, that the artery in its course is successively in relation with the ramus of the jaw, the pterygoïd muscles, the pterygo-maxillary fissure, and the floor of the orbit. As at each of these stages of its progress it gives off branches, we may follow

the plan of arrangement indicated by Cloquet, and divide them into four sets, corresponding with the points above referred to.

529. 1. Branches of the internal maxillary artery given off near the ramus of the jaw.

a.—A *tympanal branch* (*arteria tympanica*) passes deeply behind the articulation of the lower jaw, and enters the fissura glasseri, supplying the laxator tympani, and ramifying in the cavity of that name, as well as on its membrane.

b. — *meningea parva* sometimes arises from the succeeding branch, or from one of those given to the pterygoïd muscles. It ascends between the pterygoïd plate and the circumflexus palati, and enters the skull, through the foramen ovale, to supply the dura mater.

c.—*meningea media, vel magna*, is by far the largest of the branches given to the dura mater. It passes directly upwards to the foramen spinale, which transmits it to the interior of the skull, where it will be observed to run in a groove marked on the great ala of the sphenoïd bone, the squamous part of the temporal and the inferior angle of the parietal. From the last point it branches out, its ramifications corresponding with the arborescent lines traced on the cranial bones, but intimately connected with the dura mater, so that if the latter be detached from the skull, the artery and its branches will be carried with it.

d.—*Ramus maxillaris inferior, vel dentalis*, enters the dental canal, accompanied by the nerve of the same name, and runs from behind forwards to the foramen mentale, through which it escapes on the face. In its course the vessel lies beneath the roots of the teeth, and gives at intervals small twigs, which ascend and enter the minute apertures in their points, and finally ramify in the pulp of each tooth. Near the foramen mentale a branch passes forwards, beneath the incisors, which it supplies and inosculates at the symphysis of the chin, with a corresponding artery from the opposite side. Its terminal branches on the face anastomose with the coronary and submental arteries.

530. 2. Branches given off whilst the artery is between the pterygoïd muscles.

e.—Two or three branches (*temporales profundæ*) ascend between the temporal muscle and the cranial bones, along which they ramify, freely supplying the muscle.

f.—Some small and short ramusculi pass to the pterygoïd muscle, which they supply (*pterygoïdeæ*).

g.—A small but regular branch (*masseteric*) passes from within outwards through the sigmoïd notch in the lower jaw, and is distributed to the masseter.

531. 3. The branches given by the internal maxillary artery whilst opposite the pterygo-maxillary fissure.

h.—*Ramus buccalis* passes obliquely forwards upon the buccinator muscle, to which and to the other muscles of the cheek it distributes twigs, and anastomoses with the facial artery.

i.—*alveolaris vel dentalis superior* turns forwards on the border of the superior maxillary bone, and gives off several small twigs, some of which pierce the bone, and reach the antrum Highmori, where they ramify freely, whilst others penetrate to the alveoli by similar foramina, and enter the roots of the upper teeth to supply their lining membrane.

k. — *infra orbitalis* turns horizontally forwards from the artery, when it has reached the spheno-maxillary fossa, and enters the infra-orbital canal, when it sends some twigs into the orbit to supply the inferior oblique muscle and the lachrymal gland. It emerges on the face, after having traversed the canal, and sends twigs upwards and inwards to the lachrymal sack and angle of the eye, which communicate with the nasalis lateralis, whilst others descend, covered by the elevator of the lip, and anastomose with the transversalis faciei and buccal branches.

532. 4. The branches given off in the spheno-maxillary fossa.

l. —*palatina superior vel descendens* is one of the three branches into which the artery may be said to divide at the point just indicated. It passes perpendicularly downwards, through the posterior palatine canal, and so reaches the arch of the palate, along which it ramifies, supplying the gums and soft palate, and anastomosing with the nasal artery by a branch sent up through the foramen incisivum. At its point of origin, a reflected branch passes directly backward to enter the vidian canal with the nerve of the same name. Hence it is termed the *vidian* or pterygoïd branch. It is distributed to the Eustachian tube and top of the pharynx.

m. — *pterygo-palatina* is a very small ramusculus, which passes backwards and upwards to reach the pterygo-palatine foramen, by which it reaches the top of the pharynx, where it freely ramifies, after having given some twigs to the Eustachian tube and sphenoïdal cells.

n.—The *nasal* or *spheno-palatine* artery enters the foramen of that name, by which it reaches the cavity of the nose, at the posterior part of the superior meatus. There, lying between the mucous membrane and the bone, it divides into two or three ramusculi; one of these ramifies on the septum narium, the others on the spongy bones, some twigs being sent into the posterior ethmoidal cells as well as the antrum.

533. The vessels here described, as arising from the external carotid, present several varieties in their mode of origin in different instances, and some also as to the relative size of the branches, which two or more of them send to the same parts. If the supply from one quarter be greater than usual, that from another will be proportionally diminished, by the operation of a principle of compensation so constantly observable in the distribution of vessels. If these arteries were merely branches from a common trunk, we should have marked their gradation by a smaller type; but, if viewed in a general way, it will be found that each of them is intended for a particular organ or system of organs, and therefore should be treated as a trunk in itself, or a special source of supply to the parts to which it is distributed. Thus, the vocal, and part of the respiratory apparatus, are supplied by the superior thyroïd artery, ramifying on the exterior as well as in the interior of the larynx. The upper part of the digestive tube derives its blood from the lingual, the palatine, and pharyngeal arteries. The face, including the organs of expression and mastication, receives necessarily several vessels, the facial and internal maxillary arteries being the chief, whilst the occipital and temporal ramify on the cranium. This arrangement was first suggested by Bichat, and may be considered merely as an indication of his constant anxiety to make physiology the basis of his classifications.

The subclavian Artery.

The two vessels of this name differ in length, relations, and size, in which particulars they may be compared and contrasted as follows:

534. The *right* subclavian, having commenced at the division of the innominata, behind the sterno-clavicular articulation, arches upwards and outwards to reach the margin of the scalenus anticus. It there inclines outwards and downwards, beneath the clavicle and subclavius muscle, becoming continuous with the axillary artery, at the lower border of the first rib. The vessel lies on a plane anterior to that of the left side, inasmuch as the innominata, from which it arises, is borne forwards by the trachea; and, in its course, it describes a curve, whose convexity looks upwards, being in contact with the lower nerve of the brachial plexus, whilst its concavity looks

The *left* subclavian artery arises from the transverse part of the aortic arch, at its most depending point, and thence ascends almost perpendicularly to get to a level with the first rib, lying close to the vertebræ, and supported by the longus colli. It is overlapped by the upper lobe of the lung, and the reflected part of the pleura, and crossed at its lower part by the nervus vagus (which had previously been parallel with it) and above, by the left vena innominata, which separates it from the sternum, and sterno-thyroïd and sterno-hyoid muscles. The artery lies parallel with, and close to the œsophagus. On reaching the margin of the first rib it turns suddenly out-downwards, resting on the pleura and first rib. The vein lies on a plane, anterior to the artery, being separated from it by the scalenus anticus, but is somewhat lower down, so as not to obscure or overlap it, except when much distended. Previously to reaching the scalenus the artery is covered by the skin and fascia, by the origin of the sterno-mastoïd and the platisma, and is overlapped by the sterno-hyoideus and sterno-thyroideus muscles; it is also crossed by the nervus vagus and jugular vein; but external to the scalenus, though still deeply seated, it is covered only by the skin, platisma, and fascia, with some cellular membrane, and will be found lodged in a triangular interval, the base of which is formed by the clavicle, and the sides by the scalenus and omo-hyoideus. This is the situation in which the artery can be most easily compressed or ligatured.

wards, behind the scalenus, and thenceforward follows the same course, and maintains the same relations as the right subclavain. But up to that point it lies so deeply, and changes its course so suddenly when passing outwards behind the scalenus, that it is found impossible to apply a ligature upon it previously to reaching that muscle,—an operation which has been performed with success on the corresponding part of the right subclavian.

535. Seven branches proceed from the subclavian artery, each to a different destination: three of these, however, arise by a common trunk.

The internal mammary and superior intercostal arteries proceed down into the thorax; the inferior thyroïd, and the vertebral pass up to the forepart of the neck; the profunda cervicis directly backwards, to its posterior aspect, whilst the supra-scapular and posterior-scapular pass transversely outwards, to ramify—the former on the dorsum scapulæ, the latter along its posterior border.

536. 1. *Mammaria interna* turns forwards from the subclavian to reach the inner surface of the first rib, and then descends between the costal cartilages and the pleura, as far as that of the seventh rib. At this point it divides into two branches, one of which inclines outwards, along the margin of the thorax, the other continues in the direction of the vessel, down into the abdomen. Its branches, including the two just alluded to, are as follows: *a. Comes nervi phrenici* is a very small branch, which joins the phrenic nerve, where it passes over the mammary artery, or a little lower, and accompanies it to the diaphragm, to which its ramusculi are distributed, anastomosing with the phrenic branch of the aorta. *b.* Several small branches (*mediastinæ*) pass inwards to the cellular tissue in the anterior mediastinum, and also some to the anterior part of the pericardium.

c. The *external branches* (*intercostales anteriores*) pass outwards, at each intercostal space, between the pleura and intercostal muscles, then between the two layers of the latter, and inosculate with the vessels of the same name, derived from the aorta, maintaining communications at the same time with the thoracic branches of the axillary artery.

d.—Musculo phrenica is the external division of the mammary artery. It inclines outwards, in the direction of the cartilages of the false ribs, sending branches, backwards into the diaphragm, and downwards to the abdominal muscles, whilst others pass outwards, in the intercostal spaces, being disposed in the same way as those that come from the mammary itself.

e.—Epigastrica superior continues in the direction of the mammary artery, descending between the rectus abdominis and the peritonæum, ramifying freely in the muscles, and anastomosing with the inferior epigastric, which comes up from the iliac artery.

537. 2. *Intercostalis superior* turns backwards, immediately after its origin, from the posterior aspect of the subclavian, and

reaches the inner surface of the first rib, beneath which it sends outwards an intercostal branch, similar in course and distribution to those derived from the aorta. Opposite the second intercostal space another branch is given off, after which it terminates by a small ramusculus, that communicates with the first aortic intercostal branch. Some twigs are given to the upper part of the œsophagus, and some also enter the intervertebral foramina, to ramify on the dura mater of the spinal canal.

538. The *thyroïd* axis is so called, because immediately after its origin, it divides into three branches, which diverge in different directions, viz. the thyroidea ascendens, transversalis colli, and transversalis humeri.

539. 3. *Thyroïdea ascendens* passes upwards, resting on the longus colli, but soon turns inwards, behind the sheath of the cervical vessels and the sympathetic nerve, to reach the thyroïd gland, in which its final branches ramify, communicating with those of the superior thyroïd artery, derived from the carotid. At the point where the inferior thyroïd changes its direction, a small branch usually arises from it, (*cervicalis ascendens*) and proceeds upwards, on the line of junction formed by the scalenus anticus and rectus anticus major, ramifying on these muscles, and communicating with the ramusculi sent outwards from the vertebral artery.

540. 4. *Transversalis colli* (*scapularis posterior*) passes directly outwards across the lower part of the neck, resting on the scaleni muscles and axillary plexus. On reaching the posterior angle of the scapula, it changes its direction, and turns downwards, along the base of that bone, as far as its inferior angle, where it freely anastomoses with the subscapular branch of the axillary artery. This vessel sometimes arises singly from the subclavian, and passes through the plexus. It lies deeply in its entire course, and gives off several branches. Opposite the anterior border of the trapezius a branch passes upwards, becoming superficial (*cervicalis superficialis*) and distributes ramusculi in the interval between the trapezius and sterno-mastoïd muscles, supplying both, as well as the cervical glands and integuments. The proper *posterior scapular* branch is in fact the continuation of the vessel, and will be found at the posterior angle of the scapula, under cover of the levator anguli muscle, and subsequently under the rhomboidei, to which it gives several branches, as well as to the latissimus dorsi

and intercostal muscles, anastomosing at the same time with the intercostal arteries.

541. 5.—*Transversalis humeri* (*supra-scapularis*) is smaller than the preceding, but takes a similar course under cover of, and parallel with the clavicle, to reach the root of the coracoïd process of the scapula. At this point it is separated from the corresponding nerve by the ligament stretched across the supra-scapular notch, as the nerve usually passes through the foramen. On reaching the supra-spinous fossa, the artery lies close to the bone, and sends outwards a branch (*supra-spinalis*) which ramifies in the supra-spinatus muscle. Continuing to descend, the artery in the next place passes through the interval between the glenoïd cavity and the spine of the scapula, resting on the neck of that bone, and so reaches the infra-spinous fossa, where it supplies the muscle of that name, and at the same time communicates with the dorsal branch of the subscapular artery, and the termination of the scapularis posterior.

In its course across the neck some ramusculi are given by this vessel to the muscles by which it passes. A small, though regular branch, will also be found to pass obliquely downwards to the cutaneous surface of the acromion (*ramus acromialis*) on which it distributes several twigs, which anastomose with those of the thoracica acromialis.

542. 6.—*Profunda cervicis* is subject to many varieties in its point of origin as well as size. It passes backwards in the interval between the transverse processes of the sixth and seventh cervical vertebræ, and on reaching their dorsal aspect ascends, still deeply seated, and sends off several branches to the surrounding muscles. Some of these communicate with ramusculi, sent outwards from the vertebral artery, whilst others ascend to anastomose with the descending branch (*princeps cervicis*) of the occipital artery.

543. 7. The *vertebral artery* is of considerable size, and at the left side appears like the continuation of the subclavian. It enters the foramen in the transverse process of the fifth or sixth cervical vertebra, and ascends vertically, lodged in the canal formed by the chain of foramina in the transverse processes, and so reaches the cranium. Its course and distribution shall be examined when we have described the brain.

SECTION IV.

VEINS AND LYMPHATICS OF THE NECK AND FACE.

544. The blood from the cranium and face is returned by two trunks, differing in their mode of origin, position, and size. The external jugular vein, much smaller than the internal, and comparatively superficial in its course, commences a little below the zigoma, and in the substance of the parotid gland, being formed by the junction at that point of the temporal and internal maxillary veins. 1. The *temporal vein* in direction and course corresponds with the artery of that name, having commenced at the side of the head by several branches, which converge as they descend, and form a single vessel. 2. The *internal maxillary* vein bears a similar relation to the internal maxillary artery, and commences by ramusculi, which receive the residue of the blood circulated by that vessel and its numerous branches. The trunk of the vein lies near the corresponding artery, behind the ramus of the jaw, where it unites at an angle with the temporal vein. In this situation we find the stylo-mastoïd vein also, after having descended from the cavity of the tympanum, and the auricularis posterior from the external ear. The *external jugular vein* formed by the conflux of these vessels, descends at first through the substance of the parotid gland, and afterwards between the sterno-mastoïd and platisma; finally, after having passed along the posterior border of the former, it dips beneath it, and terminates in the subclavian vein. In this course it receives, at intervals, branches from the superficial parts of the neck.

545. The *internal jugular vein* is of considerable size, and deeply seated in its entire course. It commences in the *jugular fossa*, being part of the foramen lacerum posterius, where it is continuous with the lateral sinus of the brain. Placed at first close to the internal carotid ar-

tery, it subsequently lies parallel with, and to the outside of the common carotid, as far as the sternal end of the clavicle, where it joins at an angle with the subclavian vein, and so forms the *vena innominata*.

Several large branches terminate in the internal jugular vein. The *occipital vein* opens into it from behind, and those corresponding with the anterior branches of the carotid artery from before. The *facial vein* commences by a straight branch, which descends from the fore-head to the root of the nose. Having reached the angle of the eye, it comes into contact with the terminal branches of the facial artery, whose course it follows, receiving ramusculi as it descends along the side of the face. From the margin of the jaw-bone the vein inclines downwards and outwards to open into the internal jugular vein, opposite the upper border of the thyroïd cartilage. The *lingual* and *superior thyroïd* veins follow the course of the arteries of the same name, both terminating in the internal jugular, as do likewise the inferior thyroïd veins, which arise from the lower part of the thyroïd gland, and descend on the fore part of the trachea, but incline outwards previously to their termination.

Lymphatics of the Face and Neck.

546. The lymphatic vessels of the face and neck consist of a deep and superficial set, which in their course follow that of the vessels described in the preceding section. The superficial lymphatics of the face accompany the facial vein, and with it sink into the neck below the lower jaw, where they pass through some superficial glands, and maintain communications with the deep lymphatic vessels. Those from the side of the head take the course of the temporal vessels, and, at the angle of the jaw, join with the facial set, or merely communicate with them. From this point two or three trunks descend by the side of the trachea, and along with the external jugular vein, to termi-

nate at the left side in the thoracic duct, and at the right in the lymphatic trunk of that side. Lymphatics have not been discovered in the substance of the brain. They have however been seen ramifying in the dura mater along the course of the vessels. The deep lymphatics of the face follow the course of the internal maxillary vessels, and enter the superior cervical glands, and thence descend along the chain of these bodies placed in the course of the great cervical vessels, connecting one with the other. Hence they are termed *glandulæ concatenatæ*. Their termination is similar to that of the superficial lymphatics.

SECTION V.

NERVES OF THE NECK.

547. The nerves proper to the neck are derived from the cervical plexus. We shall omit, for the present, the several cerebral nerves which pass through it to their different destinations, though they give off what may be termed cervical branches in their course. The *cervical plexus* consists of an interlacement, formed by the anterior branches of the four first spinal nerves placed at the upper and lateral part of the neck; it extends from the transverse process of the second to that of the fourth vertebra, resting on the fibres of the posterior scalenus and levator scapulæ muscles, and concealed by the sterno-mastoïd. Each nerve, as it passes through the inter-vertebral foramen, divides into a posterior and an anterior branch, the latter going to the plexus, the former destined for the muscles at the back part of the neck.

548. The *posterior* branch of the fourth is smaller than either of those above it, except the first. It passes directly backwards between the transverse processes, and having given several filaments to the complexus muscle, pierces the splenius, and trapezius, supplying both, and ultimately terminates in the integuments. The *posterior* branch of the

third nerve is of considerable size; it pierces the muscles, and ascends, becoming subcutaneous, and ramifies extensively on the back part of the head. The *posterior* branch of the second passes backwards and upwards, covered by the complexus, and resting on the rectus posticus and obliquus inferior. To these, as well as to the splenius, it gives ramusculi, and finally becomes subcutaneous, ramifying in the skin of the occiput.

549. The *first* cervical nerve (*sub-occipitalis, decimus cerebri*) is the smallest of the spinal nerves, except the last sacral. Willis and several succeeding anatomists considered it as one of the cerebral nerves, but Soëmmering, Meckel, and Bell, have on just grounds associated it with those that arise from the spinal column, because like them it arises by two roots, presents a ganglion on the posterior one, and in its general distribution is analogous to those which succeed it. Yet, as there are some points in which it differs from them, we may regard it as intermediate not only in position, but also in conformation between the regular symmetrical nerves, and those which arise from the cranial part of the central mass. This nerve passes out between the arch of the atlas and the occipital bone, lying in the groove on the upper surface of the former, and reaches the triangular space, bounded by the recti and obliqui muscles, where it divides into an anterior and posterior branch. The latter resolves itself into four or five filaments, which are distributed to the small muscles just mentioned, and to the complexus. It may be here observed, that the posterior branches of the three upper cervical nerves mutually communicate by a filament sent from one to the other, previously to their final division, so that an interlacement is formed between them, though it does not receive the name of plexus. The *anterior* branch of the first cervical nerve, smaller than the posterior, runs obliquely forwards upon the transverse process of the atlas, and, on reaching the anterior surface of the spinal column, descends and joins with

a branch sent up from the second nerve, having previously given some filaments to the muscles by which it passes. At the point of union also some twigs are sent to communicate with the lingual and vagus nerves at the base of the skull. The anterior branches of the second, third, and fourth nerves will be observed as soon as they appear on the forepart of the neck to send filaments mutually, one to the other, in order to form the cervical plexus, whose branches are divisible into a superficial and a deep set; the latter being placed under cover of the sterno-mastoïd, whilst the former lie immediately beneath the fascia, one part of them passing up towards the jaw and ear, the other down to the clavicle.

550. 1. The *ascending superficial branches*, from the plexus, are three in number. They turn round the posterior border of the sterno-mastoïd, and will be observed to differ in size and direction, as they lie upon its cutaneous surface. *a*. The *middle* or largest branch (*nervus auricularis magnus*, Soëmm., *zigomato-auriculaire*, Chauss.) ascends perpendicularly towards the interval between the lobe of the ear and the angle of the jaw, lying close to the external jugular vein, and, on reaching the parotid gland, divides into branches, one or two of which pass deeply into its substance, and join with those of the facial nerve. The rest of the branches remain superficial, and ramify on the integument of the external ear, some at its facial, and one or two at its occipital aspect. *b*. The internal branch (*superficialis colli*) inclines obliquely up towards the submaxillary gland, giving filaments to the platisma and digastricus, also one or two, which join with the cervical branches of the facial nerve: it finally divides into delicate filaments, which interlace with those of the chorda tympani, as they ramify on the sub-maxillary gland, forming a sort of plexus by their union. *c*. The *posterior* branch (*occipitalis minor*) runs along the posterior border of the

mastoïd muscle, lying on the splenius, and terminates by three or four filaments in the integument of the occiput.

551. 2. The *descending superficial* branches of the plexus will be seen in the interval between the contiguous borders of the sterno-mastoïd and trapezius, diverging as they pass down to the lower part of the neck. They are embedded in a considerable quantity of cellular tissue, and as they diverge to their destination, one set passes over the clavicle (*claviculares*) and supplies the integument on the upper part of the thorax, another on the acromion (*acromiales*); whilst some lie rather deeply behind the clavicle, being distributed to the posterior belly of the omo-hyoideus, and the serratus magnus.

552. 3. The *deep branches* are arranged into two divisions: one of these consists of two filaments, derived from the second and third nerves, which incline inwards as they descend in front of the sheath of the cervical vessels, to join the descendens noni, and form with it an inverted arch. From the convexity of this arch, which looks downwards, three or four long waving filaments proceed towards the front of the neck, where they are distributed to the sterno-hyoideus and thyroïdeus, as well as to the omo-hyoideus muscles. The other deep branches are two, which converge and unite on the scalenus anticus to form the *phrenic nerve*. These will be observed to come from the third and fourth nerves; but they are further increased by a branch derived from the fifth, as it descends to the axillary plexus. The phrenic nerve thus constituted lies on the scalenus anticus, and passes into the thorax, to be ultimately distributed to the diaphragm.

553. The neck is inclosed by a membranous investment, similar in its general conformation to that of the extremities, though not so firm in its structure. It is called the *cervical fascia*. We may observe " in limine," that a layer of cellular tissue lies beneath the skin, disposed in the same way

as the sub-cutaneous cellular membrane in other situations, but which is here termed the *superficial fascia*. Its chief peculiarity is, that at the sides of the neck the cutaneous muscle is developed in its interior, dividing it into two lamellæ, but before and behind that muscle it is single and undivided as elsewhere, being continuous superiorly with the cellular tissue on the face, and below with that on the thorax.

554. The *deep*, or *proper cervical fascia*, encases the neck all round, from the ligamentum nuchæ to the middle line at the fore-part of the neck, where the two lateral portions are united from the chin to the sternum. If fully exposed, by removing the platisma and superficial cellular membrane, and turning back the trapezius muscle, we may examine the distribution of the fascia as follows: Commencing posteriorly at the middle line, the fascia will be found to bind down the splenius and second layer of muscles as far as the external border of the sterno-mastoïd muscle. It there divides into two layers, one placed before, the other behind that muscle, and uniting again at its inner border, so as to form a sheath for its investment. From this point the fascia is prolonged, in front of the trachea and its muscles, to the middle line, when it unites with the corresponding portion of the opposite side. Whilst passing over the muscles just referred to, it sends thin lamellæ between them, which become attached to their respective points of insertion. If traced upwards, the lamella on the cutaneous surface of the sterno-mastoïd will be found to pass over the parotid gland, and to be thence prolonged over the side of the face, becoming thin, and gradually degenerating into cellular tissue. But externally, it is attached to the cartilaginous tube of the ear, and higher up to the zigoma. The deep lamella inclines inwards, and becomes connected with the styloïd process, from which it is again reflected to the angle of the lower jaw, forming a broad lamella, extended between these points, which constitutes a

septum between the parotid and submaxillary glands, and is usually described as the ***stylo-maxillary ligament.***

555. When examined at the lower part of the neck, the fascia will be found strained tightly across from one sterno-mastoïd muscle to the other, and thence extended down to the top of the sternum, where it divides into two lamellæ, one being continued on its cutaneous, the other on its thoracic surface, where they are firmly attached. This part of the fascia may be said to complete the wall of the thorax, and to bear off the pressure of the atmosphere from the air-tubes in inspiration. External to the sterno-mastoïd, the superficial layer of the fascia passes over the clavicle, and is continued down, becoming thin and cellular on the pectoral muscle. But the deep-seated lamella, after having sent back a process which forms a sheath for the tendon of the omo-hyoideus, reaches the border of the subclavius, where it divides into two layers, of which one passes before, the other behind that muscle, so as to invest it. At its lower border both these unite again, and become attached to the coracoïd process, on the one hand, and the cartilage of the first rib on the other, forming a dense lamella in front of the subclavian vessels, and called the ***costo-coracoïd membrane*** or ***ligament.*** At first sight, it appears to cease at this point by a lunated border, but, on closer inspection, it will be found to be prolonged down over the thorax, becoming thin and cellular as it descends.

The *dissection of the face* may be commenced by making an incision from the vertex along the middle line of the forehead and nose, taking care that it barely divides the skin. From this, two lines may be drawn outwards, one over the zigoma to the lobe of the ear, the other over the eyebrow to the side of the head. The interval intercepted between these two parallel lines may be intersected, midway between the ear and nose, by a perpendicular line drawn from one to the other. A square piece of skin is thus marked out over the orbicularis muscle, which should be carefully reflected from its borders and angles, and dissected off that muscle, as far as the margin of the eyelids. The external flap may then be reflected back over the ear, so as to expose the temporal fascia, artery, &c. The skin, in the next place, is to be carefully raised and dissected off the frontal muscle, from below upwards over the fore-head as far as the vertex. The fibres of the orbicularis may now be divided over the eyebrow, so as to expose the corrugator supercilii; and if the lower border of that muscle be raised, it will expose the origin of the elevator of the lip, which will afford a guide to the dissection of that muscle, as well as of the common elevator of the lip and nose, down to their termination. In order to expose the muscles and vessels of the lower part of the face, an incision may be made from the most prominent point of the cheek to the margin of the jaw, from which the skin may be reflected backwards off the masseter muscle and parotid gland, taking care not to injure the duct of the latter, or the nerves and artery which accompany it; but the other flap of skin is to be carried obliquely inwards to the lip, in the direction of the zigomaticus. By this measure, the last-named muscle, and the levator anguli oris, and also the facial artery, will be exposed; and by removing some adipose substance, the buccinator will be brought into view. By turning aside the elevator of the lip, the second branch of the fifth nerve and the infra-orbital artery will be seen emerging from the foramen of that name. The masseter muscle and parotid gland having been examined, the parts concealed within the ramus of the jaw may be brought into view in the following way: With a sharp chisel and mallet the zigoma may be divided at both extremities, and the attachment of the temporal fascia to its upper border severed. The bony arch, with the masseter still connected with it, may be drawn down to the angle of the jaw, the fibres of the latter being at the same time detached from the ramus. In the next place, with Hey's saw, the ramus of the jaw may be divided by a perpendicular cut, carried from just before its condyle, to a level with the alveolar border, and there met by another line carried forwards to the latter, so as to insulate and detach all that part of it that belongs to the coronoïd process. This being done, the piece of bone with the temporal muscle attached, may be drawn upwards, so as fully to expose the two pterygoïd muscles, the internal maxillary artery, the gustatory and dental nerves, and the pterygo-maxillary ligament, which gives attachment to the buccinator and superior constrictor muscles. A large branch of the facial nerve will be found accompanying the parotid duct. This will serve as a clue to the trunk of that nerve, by following it back through the substance of the parotid gland; and when the trunk is found, there can be no difficulty in pursuing all its branches, as they diverge from that point in three different directions over the face and side of the head.

Dissection of the neck.—The head being allowed to hang over a block placed behind the neck, and the side of the latter being turned forwards, we may proceed to examine it as a surgical region. In this view it presents itself to our notice as a quadrilateral space, bounded below, by the clavicle, above by the margin of the jaw, and a line continued back from it to the mastoïd process;—before, by the median line, extended from the chin to the sternum, and behind, by another from the mastoïd process to the external third of the clavicle, thereby coinciding with the border of the trapezius. The dissection may be commenced by making two incisions through the skin, corresponding with the two last-mentioned lines. Now, the whole space is divided into two triangles by the sterno-mastoïd muscle, which runs diagonally through its area, each of which requires a particular examination; for in the upper triangle, whose base corresponds with the margin of the jaw, and whose apex lies at the sternum, is lodged the carotid artery; and in the external and inferior space, the base of which corresponds with the clavicle, the subclavian artery is placed in the situation in which it may be compressed or tied. When proceeding with the dissection, an incision may be made through the skin over the sterno-mastoïd, so that the angular flaps thus marked out may be raised and reflected, one upwards over the face, the other down on the chest. This will expose the platisma in its entire extent; the direction of its fibres should be carefully considered in reference to the operation of opening the jugular vein. If the point of the lancet be directed upwards and forwards in the course of its fibres, it will merely make a fissure between them, and when withdrawn they will contract, and close over the wound in the vein, so that the operation is rendered ineffectual, and probably an ecchymosis will be produced. But if it be directed upwards and outwards, the fibres will be cut across and retract, so as to expose the vein, and the aperture made in it. The platisma should be reflected from below upwards over the face, beginning at the clavicle, by which means, particularly if the trapezius be turned back, the cervical fascia will be fully exposed. When this membrane is dissected off the sterno-mastoïd, we see lying on it the ascending nerves of the cervical plexus, and passing downwards the descending set. In the area of the superior triangular space will be found the submaxillary gland and digastric muscle, and lower down the sheath of the vessels, inclosing the carotid artery, jugular vein, and vagus nerve. On the sheath the descendens noni lies, and behind it the sympathetic nerve. The inferior triangular space will be found divided into two parts by the omo-hyoideus passing across it; the upper division containing the cervical plexus, the lower the axillary plexus, and the subclavian artery. The upper belly of this muscle also divides the superior space by passing across the sheath of the vessels; all that part of the carotid below it being deeply seated and covered by muscles, whilst the rest is comparatively superficial. When these parts have been examined, the jaw may be sawed through at the symphysis of the chin, and at the margin of the masseter muscle, the mylo-hyoideus having been previously detached from its connexion with the os hyoides. These being removed, the side of the tongue, the gustatory nerve, the sublingual gland, and the hypo-glossal nerve, are brought into view, together with the muscles.

When describing the fascia, mention has been made of the fact, that processes pass inwards, investing the muscles in front of the larynx; similar lamellæ are also extended to the cervical glands. Now, enlargements of the latter often simulate the characters of aneurismal tumours of the contiguous artery, so that their diagnosis is difficult. The facts, however, just alluded to, will go some way to clear up the difficulty; for if the patient be desired to make an effort, as if to swallow, the larynx will ascend, and with it the fascia, by reason of their connexion, and the latter will at the same time draw up the tumour, if it be merely glandular; all these parts will subside when the effort ceases.

An attention to the anastomoses of vessels will at once shew how the circulation is carried on after one of their trunks has been obliterated. If the common carotid be tied, the thyroïd, lingual, and facial branches of that side, at once receive blood from the corresponding vessels of the opposite, by means of their anastomoses along the middle line, and circulate blood freely, but in a direction the reverse of that in which it had previously flowed in them. The internal carotid and vertebral arteries are supplied from the great arterial circle at the base of the brain, part of which they form. If the subclavian be tied externally to the scalenus, all its branches are left open to receive the increased current which is thrown upon them, and are enabled by gradual dilatation, to supply the place of the obliterated trunk. Its scapular arteries convey blood into the subscapular branch of the axillary, so does the mammary into the thoracics of the latter, and the brachial and lower part of the axillary artery are filled in a very short time. But when the subclavian is tied before its branches are given off, the route of the new circulation is much more circuitous. The carotid then becomes the medium of supply. Its thyroïd branch conveys blood into that of the subclavian; the occipital artery, by means of its descending branch, imparts its surplus to the profunda cervicis, whilst the vertebral is abundantly supplied from the arterial circle in the brain, the new current in it flowing from above downwards. This inversion of the current in vessels, under certain circumstances, deserves attention. Suppose the carotid to be tied, the part of the artery above the ligature soon fills with blood, which flows in it from above downwards, being derived from its superior anastomoses with the vessel of the opposite side. Were secondary hæmorrhage to occur, so as to require the application of a new ligature, the direction from which the blood is coming should be ascertained, if possible, before the attempt is made. For here is a case in which it may be necessary to apply the ligature beyond the original one, or two may be required, one at each side of it.

Little has been here said concerning the dissection of the muscles, because little or nothing need be added to what has been already stated in their description. They will be found, grouped into sets, according to their anatomical relations; and the first line of the description indicates their position, whilst the rest contains all that relates to their attachments, with occasional notice of their form and structure.

When the anterior and lateral parts have been examined sufficiently, the trachea and œsophagus may be cut across a little above the sternum, and both together drawn forwards. There then can be no difficulty in detaching the pharynx from the muscles in front of the vertebral column, as they are merely connected by loose cellular tissue. When this is done, a piece of cloth should be carried deeply to the base of the skull and drawn across the pharynx, to serve as a retractor whilst the saw is being used. The edge of the saw should, in the next place, be applied behind the styloïd processes, so as to cut through the base of the skull, and detach the face, with the pharynx and larynx all pendent from beneath it. The pharynx should be stuffed, to render its muscles tense. When its exterior is sufficiently examined, a longitudinal slit made along the middle line posteriorly, will expose its cavity, and that of the mouth and larynx. The small muscles of the latter are at once exhibited by detaching the mucous membrane, to which they are but very loosely connected. The levatores palati are also brought into view, by removing the mucous membrane from the posterior surface of the soft palate; the circumflexi will be found along the internal pterygoïd plates; their aponeurosis, which form the fundamental part of the soft palate, will be seen in front, by dissecting off a thick layer of granular substance, which is continued downwards upon it beneath the mucous membrane.

Operations.—In performing laryngotomy, after the patient has been properly adjusted, the skin may be pinched up into a fold, running across the interval between the cricoïd and thyroïd cartilages, and divided down to its base, or point of reflection. When allowed to subside, it will present a longitudinal incision, extending from above downwards. The fascia must, in the next place, be divided, and then the crico-thyroïd membrane is exposed, but previously to puncturing it, its surface should be examined, to ascertain whether a small artery runs upon it. If so, it would be well to pass a needle beneath it, and tie it, or tear it across; for, if lacerated, it will be far less likely to bleed than if simply divided. The membrane may then be punctured, or rather, a crucial incision may be made in it. Cases of this sort, when successful, are still attended with one very disagreeable consequence, namely, that though the process of healing goes on well for a while, the union is incomplete, by reason of the adhesion of the margin of the skin to that of the membrane, so that a fistulous orifice remains. Now, does not this indicate the necessity of making the first incision through the skin, so that it shall not correspond with that in the membrane? Might not the fistula be avoided by making a small oval flap, and reflecting it back, so as to expose and puncture the membrane? When the operation is over, the flap may be restored to its place, without any fear of such an occurrence as that above noticed.

The *carotid artery* may be exposed and tied as follows: the chin being turned to the opposite side, and pushed upwards so as to extend the parts, an incision, three inches in length, may be made along the inner border of the sterno-mastoïdeus, beginning below the angle of the jaw, and continued down in the interval between the muscle just named, and the side of the larynx. The skin being divided, the platisma is to be cut through to the same extent, and afterwards the cervical fascia; in doing which a portion of the membrane should be pinched up by the forceps, and cut across, so as to make a small opening for the introduction of a director, on which it is to be slit up. This will expose the sheath of the vessels, which may be opened with the same precaution, care being taken to avoid the descendens noni. When passing the ligature, it will be found convenient to pinch up the inner margin of the divided sheath, with the forceps, and draw it forwards. The point of the needle may then be applied closely to the outer side of the artery, by which means, whilst the nerve and vein are excluded, the instrument will be made to slide smoothly between the artery and the sheath.

When proceeding to expose the artery in the lower part of the neck, the incision through the integument should commence on a level with the cricoïd cartilage, and extend for fully three inches, down towards the sterno-clavicular articulation. The skin, platisma and fascia, being successively divided, the head must be slightly elevated, in order to relax the muscles, and allow of their being drawn aside, so as to bring the sheath of the vessels into view. When this is effected, the subsequent steps are the same as in the higher operation.

The *subclavian* artery may be laid bare by adjusting the neck in the same way as in the preceding operations, and then dividing the skin for three inches and a half over the upper border of the clavicle. The platisma and fascia may be successively divided on a director in the same direction and extent, after which a blunt probe should be employed, to tear through the cellular membrane that fills up the triangular interval in which the vessel is lodged. The external jugular vein will be found close along the margin of the sterno-mastoïd muscle, and should be carefully avoided. The subclavian vein will be observed, after the division of the fascia, behind the clavicle, alternately swelling and subsiding. This arises both from the natural flow of the current within it, as well as from the reflux caused by the action of the auricle. The hurried and agitated state of the respiratory action also exerts a considerable influence, both on the quantity of blood in the subclavian vein, as well as on that which flows from the cut extremities of the smaller veins, which are of necessity divided. If this becomes embarrassing, the operation may be suspended for a moment, and the patient slightly elevated, so as to allow him to make a full and easy inspiration, after which the regurgitation from the mouths of the vessels will cease, and the tension of the large vein will be diminished. When the omo-hyoideus is brought into view, the thin fascia which bends down its tendon may be torn through, and then the artery can be felt pulsating where it rests against the first rib. When attempting to pass the ligature its point should be directed from before backwards, and then made to turn from below upwards behind the artery, care being taken to keep it close to the vessel, so as to avoid the pleura on which it lies, and the nerves which are placed close above it.—The reader is referred to Burn's *Anatomy of the Head and Neck*, and Harrison on the *Surgical Anatomy of Arteries*.

CHAPTER VIII.

THE ABDOMINAL VISCERA.

556. The abdomen is the largest cavity in the body; it extends from the diaphragm, which forms its upper boundary, to the levatores ani, and from the transversales in front, to the spine, quadrati lumborum, and iliaci behind. In these structures, which form the walls of the cavity, several apertures exist for the transmission of parts into and out of it. Superiorly there are three in the diaphragm, for the aorta, œsophagus, and vena cava; inferiorly there are two at each side for the crural vessels, and spermatic cord; in front there is one—the umbilicus, for the umbilical arteries and vein. To these may be added the several interstices and apertures, which give passage to the obturator, sciatic, pudic, and gluteal vessels.

557. The organs contained in the abdomen are divisible into three sets, viz. the digestive, the urinary, and part of the generative. The first class includes the stomach and intestines, the spleen, the liver, the pancreas, and the lacteal vessels, with their glands; the second comprises the kidneys and supra-renal capsules, with the ureters and bladder; and the third—the spermatic vessels and ducts, with the vesiculæ seminales in the male, and the uterus, with the ovaries and Fallopian tubes, together with the vagina, in the female. Having already stated the division of the abdomen into regions, and the views which influenced its adoption, (sect. 329) we shall here briefly enumerate the organs, or parts of organs, contained in each region, previously to entering on their detailed description.

The epigastric region contains	The middle part of the stomach, with its pyloric extremity, the left lobe of the liver, the hepatic vessels, and lobulus Spigelii, the pancreas, the cœliac axis, the semilunar ganglia, part of the aorta, vena cava, and crura of the diaphragm.
The left hypochondriac . .	The large end of the stomach, with the spleen, and head of the pancreas; part of the colon, the renal capsule, and upper part of the kidney.
Right hypochondriac . . .	The right lobe of the liver, with the gall-bladder; part of the duodenum, and of the ascending colon, the renal capsule, and part of the kidney.
Umbilical	Part of the omentum and mesentery; the transverse part of the duodenum, with some convolutions of the jejunum.
Right lumbar	Ascending colon, lower half of the kidney, and part of the jejunum.
Left lumbar	Similar parts at the opposite side.
Hypogastric region . . .	The convolutions of the ileum, the bladder in children, and in adults, if distended; the uterus, under like circumstances.
Right iliac fossa	The cæcum, ileo-cæcal valve, the ureter and spermatic vessels.
Left iliac fossa	Sigmoïd flexure of colon, the ureter, and spermatic vessels.

Organs of Digestion.

558. The *stomach* (*ventriculus*) is a hollow, musculo-membranous viscus, occupying part of the left hypochondriac and epigastric regions. Its form is somewhat conical, being also curved, so as to incline downwards and forwards. It is in intimate relation with many important organs; it lies beneath the diaphragm and liver, above the transverse colon, having the spleen on its left, and the duodenum on its right, whilst its anterior surface is in contact with the wall of the abdomen, and the posterior rests on the pancreas and great vessels. It is usual to consider successively its surfaces, borders, and extremities. When empty, one surface looks forwards, and the other backwards; but when distended, its body changes its position, so that the former is inclined upwards, the latter obliquely downwards, by which means the great curvature comes towards the anterior parietes of the abdomen, whilst the lesser looks towards the spine and large vessels. The lower border of the stomach is of considerable extent, and is named its *greater curvature;* opposite the spleen it expands very much, bulging out into a sort of diverticulum. The latter part gives attachment to a fold of peritonæum, connecting the stomach to the spleen, the rest to the great omentum, and corresponds with the gastro-epiploic vessels. The upper border is concave, and forms the *lesser curvature,* which extends from the œsophagus to the pylorus, being not more than three inches in length; it is connected by the lesser omentum to the inferior surface of the liver, the coronary artery being parallel with it. The *left,* or *cardiac* orifice, is placed at the termination of the œsophagus, which appears as if inserted into the stomach, so that two thirds of that organ lie to its right, and one third to its left; it is surrounded by the branches of the coronary artery. The *right,* or *pyloric* extremity, is elongated so as to represent the summit of the cone to which the stomach has been

likened; it commences at a slight angular turn, marked by a crease or fold, and ends at a circular constricted line, which can readily be perceived at the exterior, and which, when compressed between the fingers, gives the sensation as if a cord-like ring surrounded the interior of the tube. This is the *pylorus* (πυλη, *a gate*; ουρος, *a guardian*), which may be compared to a sphincter muscle, being composed of circular fibres, so arranged that one circumference is identified with the wall of the stomach, whilst the other projects towards the central line of the canal, as if for the purpose of retaining the food in the stomach until it is digested.

559. The stomach is composed of three coats, connected together by two lamellæ of cellular tissue, which were formerly enumerated also, (particularly the one between the middle and inner coats;) and which was called the nervous tunic, from being supposed to consist of the ultimate ramification of the nerves. The external, or *serous* coat, is derived from the peritonæum, and forms but a partial investment for this, as for other organs, inasmuch as by being reflected away at its curvatures, it leaves two linear intervals there uncovered. The second, or *muscular* coat, consists of thin and pale fibres, placed on different planes, and pursuing different directions. The fibres subjacent to the serous membrane are disposed longitudinally, being continuous with those of the œsophagus, from which they spread out, as they proceed from the cardiac towards the pyloric orifice; the second layer of fibres is circular; but though no individual fibre can be found to extend farther than from a third to a half of the circumference of the viscus, yet they can sometimes constrict it towards the centre, so as to give it a sort of hour-glass contraction.* The fibres of the third order are scattered and irregular; being found only towards the splenic end of the stomach, where they in a manner decussate with the circular fibres, which

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* SIR E. HOME, *Phil. Trans.* WILSON PHILIP, *on the Vital Functions.*

in that part are rather few in number. The internal coat, called *mucous*, from its peculiar secretion, and *villous*, from the numerous delicate papilli, like the pile of velvet, that project upon it, forms part of the lining membrane of the alimentary canal, which shall be described as a continuous whole, after we have concluded our notice of the individual viscera.

The stomach derives its blood from two arterial arches which correspond with its two curvatures; the upper one being formed by the coronary artery and the pyloric branch of the hepatic; the lower by the two gastrica-epiploic branches; one being derived from the hepatic, the other from the splenic artery. Besides these, its splenic end receives the vasa brevia from the splenic artery. Its residual blood is conveyed by corresponding veins into the venæ portæ; whilst its nerves are derived from the stomachic plexus, being an offset from the great solar plexus, and from the terminal branches of the two vagus nerves.

560. The *intestinal canal* extends from the pylorus to the anus, and in the human subject varies from thirty to thirty-five feet in length. It is coiled on itself, so as to form folds or convolutions, and is divisible into two parts, differing in size and situation, as well as external conformation, the division between them being moreover marked by a peculiar valvular structure, which prevents a reflux of the ingesta after they have passed beyond it. The part of the canal between the pylorus and the valve just referred to is called the small intestine, the remainder thence onward to the anus, the large intestine. Anatomists have agreed to consider the small intestines as divisible into three parts, viz. the duodenum, jejunum, and ileum; premising, however, that they are but portions of a continuous tube, the lines of division between them being altogether arbitrary.

561. The *duodenum* has been so called, from being in its length equal to about twelve fingers' breadth. It was at one time named *ventriculus succedaneus*, as from its function and great distensibility it resembled an accessory stomach.

In its course it will be observed to curve on itself, so as to describe a considerable portion of a circle, for having commenced at the pylorus, it ends at the left side of the second lumbar vertebra, and is divisible into three portions, each presenting some circumstances deserving of notice. The first inclines upwards, and to the right side, so as to touch the gall-bladder, and soon after death becomes tinged yellow by the bile. At this point the intestine turns on itself, and descends perpendicularly in front of the right kidney as far as the third lumbar vertebra, where it again alters its direction, passing across the spine, ascending a little, so as to end at the left side of the second lumbar vertebra, where it is continuous with the jejunum. The ascending portion is covered by peritonæum in the same way as the stomach is, the descending part is covered by it only on its anterior surface, whilst the transverse part has no immediate serous investment, as it merely lies in the divergence of the two layers of the transverse meso-colon. Its muscular coat is thick, the circular fibres being more strongly marked than the longitudinal. The internal presents a great number of transverse folds, called *valvulæ conniventes*. At the angle of union formed by the descending and transverse parts of the intestine, will be observed a small papilla, marking the orifice of the biliary and pancreatic ducts, which open at that point. The superior mesenteric artery lies upon its transverse part, and the head of the pancreas is received within its curve.

562. The *jejunum* and *ileum* are so called, the former from being usually found empty after death, the latter from its position in the fossæ of that name. They occupy the interval from the duodenum to the ileo-colic valve, two-thirds being assigned to the jejunum, the remainder to the ileum. The diameter of the tube diminishes gradually as it approaches the latter point. The coats of the jejunum are thicker than those of the ileum, but they are similar in every other respect; the serous coat is derived from the

mesentery, to the circumference of which these portions of the canal are attached; and the muscular presents some longitudinal and superficial fibres, the rest forming arches of circles, but not extending round the tube. The valvulæ conniventes, which are numerous at the commencement of the jejunum, diminish in number gradually towards the ileum, and cease in the lower part of the latter.

563. The *large intestine* presents on its exterior surface a sacculated appearance, and is fixed in its situation by folds of the peritonæum. Its length is to that of the rest of the canal as 1 to 5, and is disposed so as to describe, whilst in the abdomen, an arch, the extremities of which are fixed in the iliac fossæ, the upper part of curve extending as high as the liver and stomach; whilst the terminal part descends into the pelvis, and describes another curve, corresponding with that of the sacrum. The large intestine is divided into three portions, differing in length and situation, viz. the cœcum, colon, and rectum.

564. 1. The *cœcum* is fixed in the right iliac fossa, where it forms a sort of cul-de-sac, being a short, rounded pouch, extended down from the colon, with which it is continuous, and receiving at its left side the ileum, which opens into it at an angle. It is sometimes called *caput coli*. It is covered by peritonæum in front and at the inner side, but posteriorly is left uncovered where the membrane is reflected away from it. To its lower and posterior part is attached a round elongated process, which from its resemblance to an earth-worm, is called *appendix vermiformis*. It is about three inches long, and slightly convoluted, a small fold of peritonæum serving to retain it in that condition. Its coats are as thick as those of the cœcum, both being lined by mucous membrane, whilst the muscular fibres of the one are prolonged to the other. In the early periods of fœtal life no distinction is perceptible between them; they form a long tube, projecting below the small intestine, and continuous above with the colon. But to-

wards the time of parturition, this part of the canal becomes constricted for about two-thirds of its length, the rest retaining its natural size; and so that peculiar conformation is established which we find in after life, at least in man, and one of the higher species of the quadrumana, in whom it may be regarded as a rudiment of the tabular diverticulum which is found in the rest of the mammiferæ.

565. 2. The *colon*, by reason of the curve it describes, presents three parts: of these one passes up (*ascending*) from the right iliac fossa, where it is continuous with the cœcum, as far as the inferior surface of the liver, supported on the quadratus muscle and right kidney, its external border being in contact with the wall of the abdomen, the internal with the convolutions of the small intestines. Another part (*transverse*) passes across from right to left, beneath the liver and stomach, concealed by the great omentum, and supported by the ascending layer of the transverse meso-colon. And the third portion (*descending*) extends from the spleen to the left iliac fossa, where it makes a double curve, so as to resemble the letter S, placed horizontally. Hence it is termed the *Sigmoïd flexure* of the colon. From the point just indicated, the intestine inclines inwards, passing over the border of the pelvis, and assumes the name of rectum.

566. 3. The *rectum*, or terminal part of the great intestine, extends from the left sacro-iliac symphysis to the anus, its direction being at first obliquely from left to right, as it descends to gain the median line of the sacrum. When deep in the pelvis it changes its direction, in order to pass forwards in front of the lower part of the sacrum and the coccyx, and behind the bladder, prostate gland, and vesiculæ seminales in the male, and the uterus and vagina in the female. When opposite the prostate, it makes its final turn, inclining downwards somewhat, so as to leave an angular interval between its upper surface, and the neck of the bladder. These curves may be said to indicate a di-

vision of the rectum into three parts, differing in situation and relation to contiguous parts. That part of the intestine included between the sigmoïd flexure and the first turn, which is about half its length, is covered by peritonæum in front and at the sides, and also connected by it, though loosely, to the sacrum. The middle portion, or that between the curves, is about three inches long, its direction being forwards and a little downwards; it rests on the lower part of the sacrum, the coccyx, and the coccigei muscles, whilst its upper surface lies immediately beneath the base of the bladder, and the prostate gland being separated from the former on either side by the vesiculæ seminales, and between them merely by some loose cellular tissue. This part is stripped altogether of the peritonæal coat, which is reflected off it, where it arrives opposite the points at which the ureters impinge on the base of the bladder. The lower portion is about an inch, or an inch and a half in length, its direction being downwards and a little backwards from opposite the prostate to the anus. The longitudinal fibres of the intestine cease about three or four lines from the margin of the anus, but the circular ones become considerably increased, forming a thick ring surrounding the gut, so as to merit the name of a sphincter (*sphincter internus*).

Structure.—The large intestine is composed of three tunics, like the rest of the canal. The serous coat invests the ascending and descending portions of the colon only at the front and sides, as the posterior and inner border corresponds with the interval between the lamellæ of the meso-cola; and, as its transverse arch gives attachment to the great omentum and the transverse mesocolon; it is uncovered along these points. The external surface of the cœcum and colon is marked by three narrow lines running their entire length, composed of the external or longitudinal fibres of the muscular coat clustered together, and which, by being somewhat shorter than the intestine, draw it into folds or sacculi, commencing at the cœcum, and extending to the sigmoid flexure of the colon, the rectum not being marked by any such appearance. The inner surface of the large intestine presents three prominent lines and sacculi, corresponding with those seen on the exterior, and at the junction of the ileum, with the cœcum, a valve, which deserves particular notice. When the large intestine is laid open along the right side, particularly if it has been partially dried, a narrow aperture, of an elliptic form, will be observed leading from the ileum, its greatest diameter being transverse. This narrowing of the canal is caused by two lunated folds projecting into its interior, forming a valve, (*valvula coli; v. ileo-colica; v. Bauhini*). The lower fold is the larger of the two; its convex border is attached to the line of union of the ileum with the cœcum, that of the upper or smaller fold corresponds with its junction with the colon; whilst the straight margins of both project inwards, and are in apposition one with the other. Each of these is made up of the mucous membrane, the sub-mucous cellular tissue, and the circular fibres of the ileum and large intestine projected into the interior of the canal, whilst the longitudinal fibres and serous coat are continued uninterruptedly from one to the other. If the two latter be divided all round externally at the angle of union, and the ileum drawn outwards, the valve will be effaced, and present a rounded or funnel-shaped opening.

The intestinal canal is supplied with blood from different sources. The duodenum receives branches from the pancreatico-duodenalis, the pyloric, and the superior mesenteric arteries. The jejunum and ileum are supplied from the ramifications that issue from the convex side of the great mesenteric artery—the colon from those that come from the concavity of its arch, and from the inferior mesenteric; and the rectum from the latter and the hæmorrhoidal branches. The veins all converge to form the vena portæ. The nerves are derived from the mesenteric plexus.

567. The *spleen* (*lien*) is a soft, spongy, and exceedingly vascular organ, placed in the left hypochondriac region, between the diaphragm and the stomach, and beneath the cartilages of the ribs. Its colour is deeply red, with a tinge of blue particularly round its margin. Its form is somewhat oval, being smooth and convex on the exterior, where it is in apposition with the diaphragm, and irregularly concave on the opposite side, which is divided

into two parts, but unequally, by a transverse slit (*hilus lienis*) for the transmission of its vessels. The spleen has a peritonæal investment prolonged to it from the stomach, by which, as well as by vessels, it is connected to that organ; but it has also a smooth and fibrous tunick proper to itself. The splenic artery is of considerable size. The vein terminates in the vena portæ; and its nerves are derived from the solar plexus.

568. The *pancreas* is a conglomerate gland, being composed of a number of granules aggregated together, in which respect, as well as in its function, it resembles the salivary glands with which it is classed. It lies deeply in the epigastric region, resting on the spine, and concealed by the stomach, one end being in contact with the spleen, the other surrounded by the curve of the duodenum, so that its direction is obliquely downwards, and to the right side. The gland is compressed and flat, and after the stomach is drawn upwards, it will be found still covered by the ascending layer of the transverse meso-colon. The superior mesenteric artery will be observed interposed between its lower surface and border, and the transverse part of the duodenum, and along its superior and posterior margin run the splenic vessels. The left or splenic extremity is narrow and thin; the right is broader, and called the *head* of the pancreas; a small part of it is also detached somewhat from the rest, and called the *lesser pancreas.* Its excretory duct commences by filaments that issue from the different granules, and gradually increases in size as it proceeds from left to right through the substance of the gland, and will be found nearer the lower than the upper border. Near the duodenum the duct emerges from the gland, and pierces obliquely the coats of that intestine to open conjointly with the ductus choledochus at its second curve.

The *mucous membrane,* as has been observed, (p. 32,) forms a continuous tube from one extremity of the alimentary canal to the other, being connected externally by cellular tissue to the surrounding textures, and internally presenting a moist, lubricated surface. When examined, however, in its entire extent, it will be found to differ considerably in its appearance and characters in different parts. Thus, at its upper extremity, the epidermis is prolonged upon its surface for some way, and may be traced as far as the union of the œsophagus with the stomach. The vagina also is similarly coated as far as the neck of the uterus, but the deeper seated parts appear to be protected, not by an insensible epidermis, but by the mucous secretion poured out on the surface. In the nasal fossæ, it is thicker than elsewhere, but soft and pulpy, though closely adherent to the periosteum. In the pharynx the membrane is smooth, and with scarcely any villi on its surface, but is of a deep red colour, and evidently very vascular. In the œsophagus it is pale, thin, and thrown into longitudinal folds by the contraction of the muscular fibres, and is evidently less vascular, and studded with fewer mucous glands than in the pharynx. At the cardiac orifice, the membrane is much paler than elsewhere, but as it is prolonged into the stomach it gradually assumes a delicate rosy tinge, particularly along the splenic end and great curvature.* In the small intestines the membrane is thrown into transverse folds (*valvulæ conniventes*) diminishing in number gradually from above downwards, and ceasing to be perceptible in the large intestines. Besides the valves observable at the interior of the tubes (viz. the ileo-colic, pylorus, velum palati, and the permanent folds, viz. the valvulæ conniventes, and the rugæ, which are only occasional and temporary), we find some minute elevations and depressions which deserve notice. In the first place, the whole surface is studded by a great number of fine *villi*, which have been represented as of a conical figure, the summit of each presenting a minute orifice, leading to an absorbing vessel. More recent examination has however thrown a doubt on the accuracy of the fact, as well as of the inference, as they appear to be at least in most parts lamellar rather than conical, and altogether destitute of pores or apertures. *Papillæ* are also generally diffused, being similar in their conformation to those on the surface of the tongue, but much smaller;

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* YELLOLY, *Med. Chir. Trans.*

they appear to be calculated, like the valvulæ conniventes, to increase the extent of absorbing surface. Lastly, we observe the mucous membrane, elevated by small granules placed beneath it, varying in number and size in different situations. They are for the most part convex and lenticular, with a minute pore on their exterior, which serves for the exit of their secretion. They may all be included under the general term of mucous glands or follicles; but, in the intestines, they assume a peculiar arrangement, and are divided into two classes, each being called after the name of an anatomist, who particularly described them. At the pyloric end of the stomach, the mucous glands, though numerous, are yet separated from one another by small intervals; hence they are called *solitariæ,* and also for the reason above stated, *glandulæ Brunneri:* they gradually diminish in number towards the end of the duodenum. The other set is divided into groups, (*agminatæ*) which begin in the jejunum, and become exceedingly numerous towards the lower part of the ileum; these are the *glands of Peyer.*

569. The *liver* (*hepar, jecur*) is of considerable size; it occupies the right hypochondriac, and part of the epigastric region, extending also somewhat into the left hypochondriac, and so will be found placed beneath the diaphragm, above the stomach and arch of the colon, behind the cartilages of the ribs, and before the spine—the aorta and vena cava being interposed. In this situation it is retained by four folds of peritonæum, called *ligaments,* viz. the falx, or falciform fold, on its upper surface, and the coronary, and two lateral ones, placed at its posterior border. These shall be described with the other processes of the peritonæum.

570. The form of the liver is very irregular, which imposes on us the necessity of considering separately each of its surfaces, borders, and extremities. The *superior* surface, smooth and convex in its general outline, corresponds with the arch of the diaphragm, and is divided by the falx into two parts or lobes, named from their position,—the *right* and *left lobes,* the former being considerably the larger.

The *inferior* surface is irregularly concave, and presents certain fissures, eminences, and depressions, deserving of notice. *a.* Extending from before backwards a deep groove or fissure will be observed (*sulcus umbilicalis—longitudinalis, horizontalis*) which in fœtal life lodges the umbilical vein for part of its extent, the rest transmitting the ductus venosus. In after life both these degenerate into ligamentous cords. This fissure (which in some instances is converted into a canal, by a portion of the substance of the liver being extended across it) marks the separation of the right and left lobes on the lower surface, as the falx does on the upper one. 2. Running transversely with regard to the preceding, and at right angles with it, is a second fissure, (*sulcus transversus, s. venæ portæ.*) It occupies the middle third of the transverse diameter of the liver, being somewhat nearer the posterior than the anterior border. The older anatomists likened it to a gateway, which gave transmission to the hepatic vessels, as it lodges the hepatic artery and biliary ducts, the vena portæ, with the nerves and lymphatics. 3. In front of the transverse fissure a square piece is marked off (*lobulus quadratus*), which is bounded behind by the fissure just named, before by the margin of the liver, on the left by the longitudinal fissure, and on the right by the gall-bladder. 4. Behind the transverse fissure, and concealed by the hepatic vessels and lesser omentum, projects another lobe (*lobulus Spigelii*); it projects in the form of a pyramidal mass, forming a sort of promontory between the three great veins, or rather the fissures, which lodge them, viz. the vena portæ, vena cava, and the umbilical vein. Its base is connected with the right lobe by a process which is named *lobulus caudatus*. The square and pyramidal lobes were formerly likened to the *pillars of* a gate, from which the vein also (*vena portæ*) took its name. The depressions on the surface of the liver are very slight; they merely correspond with the position of the contiguous viscera. In the left lobe a depression will be observed corresponding with the upper surface of the stomach; on the right, one for the gall-bladder, and two others, very faintly marked, indicating the points of contact of the colon and the right kidney.

The *anterior border*, which lies beneath the margin of the chest, is sharp and thin, and presents a notch, indicating the commencement of the longitudinal fissure, and sometimes another, which lodges the fundus of the gall-bladder. The *posterior and superior border* is thick and rounded; it is marked by two grooves, of which, one, broad and superficial, indicates where it rests on the spine, the other transmits the vena cava. The right extremity is rounded and thick, the left on the contrary, is thin and oblique, being directed towards the cardiac orifice of the stomach, and the spleen. The liver is dense, heavy, and of a deep red colour, with a slight purple tinge along its thin margin, which is a characteristic of the perfectly healthy condition of the organ; it is invested by the peritonæum, except at the points of reflexion of the falx, and of the lateral and coronary ligaments.

Structure.—When torn or divided the liver presents a granular appearance, so that it has been classed amongst the conglomerate glands; but any inquiry into its structure pre-supposes a knowledge of the vessels which ramify in its interior. 1. The *vena portæ* conveys to the liver the residual blood from all the chylopoietic viscera. The veins from these different sources unite in the first instance into two trunks, viz. the splenic and superior mesenteric; from the conflux of these proceeds the vena portæ, which again ramifies by branches in the liver, so that it may be said to have two sets of branches, viz. the incipient in the intestines, the terminal in the liver, both being connected by an intermediate trunk. *a.* The *splenic vein* arises in the substance of the spleen by six or seven branches, which converge and take the course of the splenic artery to the head of the pancreas, where it joins the mesenteric vein. It receives in its course veins corresponding with the pancreatic, duodenal, gastro-epiploic, and coronary arteries, and finally, a large one, viz. *the inferior mesenteric vein.*

The incipient branches of this vein commence round the rectum, where they form a sort of venous plexus. From this the vein ascends towards the sigmoïd flexure of the colon, and continues its course to the head of the pancreas, where it opens into the splenic vein. *b.* The *superior mesenteric* vein is of considerable size; its branches correspond with those of the artery of the same name, being enclosed within the mesentery, and converging to form a trunk, which passes beneath the pancreas to join the splenic vein. 1. The *vena portæ* ascends from the junction of these two veins towards the transverse fissure of the liver, and is from three to four inches in length. On reaching the point just indicated the vein divides into two branches, the left, though longer, being less in diameter than the right. These branch out like arteries in the corresponding sides of the liver, until they become capillary in its granular structure. 2. The *hepatic veins* commence by radicles continuous (as may be shewn by injection) with the terminations of the vena portæ. These gradually enlarge as they pass upwards, converging to the point at which the vena cava passes behind the liver, and pour their contents into that vein. They are usually three in number. 3. The *hepatic artery*, arising from the cæliac, ascends to the transverse fissure, where it divides into two branches, which accompany those of the vena portæ to their terminations. 4. The *nerves*, forming a plexus (*hepatic*) round the artery, are derived from the great solar plexus. 5. The *lymphatics* are exceedingly numerous; some being extended upon its surfaces, others arising from its interior, the latter following the course of the blood-vessels. They all join at the fissure, and descend in the lesser omentum, to terminate in the thoracic duct. 6. The *biliary duct* (*ductus hepaticus*) arises by minute ramusculi, continuous with those of the vena portæ, whose branches they accompany as they converge towards the transverse fissure, where by their union they form the duct. 7. A lamella of cellular membrane encloses the hepatic vessels previously to their entrance into the fissure, and accompanies them to their final termination, loosely connecting them to the substance of the organ. This has been called the *capsule of Glisson*, who supposed it to possess a contractile, and even a muscular power, and on this hypothesis sought to explain the portal circulation.* Such are the anatomical elements of which the liver is composed, its proximate constituents being the granules above noticed. These were supposed by Malpighi to be hollow in the interior, and to form follicles, or *acini*, interposed between the capillary terminations of the vena portæ and the artery, and the incipient radicles of the hepatic duct—a conjecture which is invalidated by the fact, that injections passed into the vein return by the duct without suffering extravasation. Ruysch, on the contrary, supposed them to be solid, and to consist of an interlacement, formed by the capillaries of the different orders of vessels. Now, when we consider the course of the vessels, and of the fluids they contain, we perceive that two sorts of blood are brought to each granule by the vein and artery, and that a different sort is conveyed away by the hepatic vein, whilst at the same moment a new fluid (the bile) is received and carried down by the duct: so that each granule forms the centre of a minute eddy round which the fluids turn; the mere fact of making the turn being sufficient not only to change their direction, but also to impress upon them a total alteration of character.

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* Glisson *de Anatomia Hepatis.*

571. The *gall-bladder* (*vesicula fellis*) is a membranous sack, of a pyriform shape, lodged in a slight depression at the inferior surface of the right lobe of the liver. Its position is oblique, so that its fundus inclines downwards, and to the right side, being on a level with the lower margin of the liver, whilst its body and neck are directed backwards, upwards, and to the left. Its neck tapers gradually, and is prolonged into a small tube (*ductus cysticus*) which descends and joins at an angle with the hepatic duct to form a common canal (*ductus communis choledochus*) which lies on a level with the hepatic artery, and on the same plane, the vena portæ being behind and between both. The common duct is about three inches long, it descends behind the head of the pancreas, with whose duct it comes into contact, and both together pierce the coats of the duodenum, running for three quarters of an inch between them, previously to terminating on the inner surface of that intestine. The gall-bladder is composed of two coats, united by cellular membrane; the external one is

but a partial covering, being derived from the peritonæum, the internal is a mucous lining, continuous with that in the ducts. In the neck of the sack the mucous membrane projects inwards, so as to form folds, disposed spirally, and calculated not only to favour the ascent of the bile into its reservoir, but also to graduate its flow as it descends. If the pipe of a syringe be inserted into the hepatic duct, the duodenum being at the same time laid open, and the fundus of the gall-bladder cut off, water forced along it will be found to ascend into the latter almost as soon as it appears in the intestine. This would indicate a resistance to its course at the mouth of the common duct, though nothing of the kind can be demonstrated in the human subject. The effect of the spiral lamella in the gall-bladder can be readily perceived by the manner in which the fluid ascends contrary to its gravity.

The urinary Organs.

572. The *kidneys* (*renes*) are the organs which secrete urine. They are placed deeply at the posterior part of the abdomen on either side of the vertebral column, on a level with the two last dorsal and two first lumbar vertebræ. The right is however a little lower down than the left. Each kidney is compressed, and ovoïd in its form, presenting two surfaces and two borders. The *anterior* surface, convex, lies behind the peritonæum, which separates it on the right side from the duodenum and ascending colon, and on the left, from its descending portion; the posterior is embedded in cellular tissue, and supported partly on the broad part of the diaphragm, partly on the quadratus lumborum; the external border is convex in its general outline, the internal concave, and excavated at the middle, where it presents a fissure (*hilus*) for the transmission of the vessels. The superior extremity is thick and rounded, being inclined inwards, whilst the inferior is flat, and diverges from the spine. The kidney is invested by a thin,

yet firm membrane, which turns over its concave border, and comes into contact with its pelvis, on which it is reflected, gradually degenerating into cellular tissue.

Structure. In this organ, as in the liver, we follow its component parts into its interior, with a view to ascertain their mode of arrangement, as on this, its structure depends. The fissure of the kidney lodges the pelvis or reservoir, the renal artery and vein, with the nerves and lymphatics. The *pelvis* is continuous with the *ureter*, which is the tube that conveys the urine down to the bladder. The ureter being about eighteen inches in length, and about the size of a quill, is composed of a fibrous and a mucous tunic. Opposite the fissure of the kidney, it expands into an irregularly oval and compressed ampulla, called the *pelvis*, which is partly concealed by the vessels. If the ureter and pelvis be inflated, or what is better, if they be distended with soft injection, it will be found on dissecting off the anterior wall of the kidney, that on entering its substance the pelvis gives off three tubes, one corresponding with each extremity, and another with the middle of the organ ; these again subdivide into from nine to thirteen smaller tubes, (*infundibula*) and the infundibula terminate in cup-like cavities (*calices*) formed by their extremities being depressed, or as it were, slightly inverted on themselves. Each calyx embraces the extremity of a rounded process, (*papilla*, *mammella*) and each papilla is the summit of a conical mass, whose base looks towards the convex border of the kidney, the sides being embedded in its substance. Now, each conical mass is composed of minute tubes, (*tubuli uriniferi*) of which one extremity opens on the surface of the papilla, and therefore pours its contents into the investing calyx, whilst the other, prolonged to the base of the cone, is there continuous with the capillary terminations of the arteries, from which it receives the secretion the moment it is elaborated; and so this fluid is received, and passed on successively by the tubuli, calices, infundibula, and pelvis, whose structure is similar to that of the ureter, being but so many prolongations of it. Though the mucous membrane of each calyx appears to cease where it is reflected over the surface of the papilla, yet we can scarcely avoid coming to the conclusion, that it is prolonged into the tubuli uriniferi, as there is no part of the œconomy in which an excrementitious fluid is allowed to rest on the structure of an organ, unprotected by a tegumentary membrane. Again, though the fibrous investment of each infundibulum and calyx seems also to cease at the margin of the papilla, it is more than probable that it also is prolonged, so as to become continuous with the fibres which constitute the tubuli.

The renal artery is derived from the aorta, and divides into five or six branches, previously to entering the fissure of the kidney; its branches pass between the papillæ, and so continue until they reach the bases of the conical masses, where they divide and ramify, so as to form a complete vascular net-work, encasing the inner or *tubular* structure, and so forming a *cortex* or exterior investment for it. The capillary ramifications of the artery thus disposed communicate with the tubuli uriniferi, and also with the radicles of the renal vein, which reconveys the effete blood into the course of the circulation.

573. The *ureter* descends along the lumbar region, and over the margin of the pelvis, from whence it is directed towards the base of the bladder, with which it comes into contact close to the posterior extremity of the vesicula seminalis (in the male).

574. The *supra-renal capsules* are so named from surmounting the kidneys. Each of these bodies is compressed, and rather flat; the upper border is convex, and the lower excavated by a groove, which receives the extremity of the kidney. In the fœtus they are large, and granulated in their structure, but in the adult their size is considerably diminished, and texture altered. Their interior is hollowed into a small triangular cavity, containing a viscid fluid.

575. The *bladder* (*vesica urinaria*) is a musculo-membranous reservoir, placed deeply in the pelvis, behind the pubic symphysis, and before the rectum, communicating with the kidneys by the ureters, and externally by the urethra. In infancy the bladder is elongated and pyriform in its shape, and contained altogether in the abdomen. At this period it may be considered as divisible into three portions; the rounded or upper extremity being with pro-

priety called its *fundus*, the narrow tapering part—the *neck*, the intermediate portion being the *body*. As the pelvis expands, the bladder gradually subsides into it, so as not to rise above its margin (at least in the adult) unless when distended, and at the same time assumes a remarkable change of form. It becomes a compressed oval, for the lower part of its body expands and subsides on the rectum, probably by the weight of the fluid it habitually sustains, and to this part is applied the term *base*, "*bas-fond*." Thus we are obliged to recur to the original application of the terms, in order to explain an apparent inconsistency in those employed; and the inconsistency is heightened by making the terms "fundus" and "summit" synonymous, at the same time that "fundus" and "base" are applied to different parts of the same viscus. Yet so the nomenclature runs:—that which was the fundus in the fœtal bladder is not unfrequently called "summit," because it is the highest part.

576. The direction of the bladder is oblique, being inclined somewhat forwards and upwards, from base to summit; and, as it is being gradually distended, it comes forward more and more, the neck being fixed, whilst the fundus and body curve forwards and upwards with the distension. If examined in this condition, three ligamentous cords (viz. the urachus, and the remains of the umbilical arteries) will be observed to pass from its summit obliquely upwards behind the recti muscles to the umbilicus. Into its base two tubes are inserted, viz. the ureters; and at the sides, the vasa deferentia pass obliquely backwards. Now, all that part of the posterior surface and sides of the bladder included between these lines is covered by peritonæum, the remainder being uncovered. Thus, at the fore-part, from the point of attachment of the urachus, down to the neck of the bladder, no serous covering exists. In the collapsed condition all this lies behind the pubis; but when distended, part of it rises above its margin, and is in contact with the recti muscles; inferiorly, from the entrance

of the ureters to the urethra, it is also uncovered, and on the sides, from the vasa deferentia forwards to the surface of the pelvis.

577. The base and neck are the parts which deserve the greater share of attention. The base is that depending part of the viscus which rests on the rectum. Attached to it we find the vesiculæ seminales, and vasa deferentia, so disposed as to leave between them an interval, in which the bladder is separated from the rectum only by some cellular tissue. This space is triangular in its form, the sides being formed by the vesiculæ converging to the prostate, whilst the base corresponds with the interval between the ureters. It is by no means so extensive when the parts are "in situ," as may be inferred from viewing them after they are disturbed. The vesiculæ are in close contact for some lines before they reach the base of the prostate, and as the peritonæum is being reflected off the bladder at the entrance of the ureters, it forms a curved fold, whose convexity inclines forwards in the interval between them. The *neck* of the bladder is usually compared to a truncated cone, longer below and at the sides than above. In infancy it is oblique, its direction being downwards and forwards, but in the adult it becomes almost horizontal. The posterior part of it rests on the rectum, the rest being enclosed by the prostate.

578. The inner surface of the bladder is lined by mucous membrane, continuous with that which is prolonged upwards along the ureters, and downwards through the urethra. When collapsed it presents throughout the body and fundus slight rugæ, or waving lines, which exist no longer in the distended condition. But towards the lower part, and corresponding with what we described, externally, as the base, a smooth and slightly raised surface appears, in which no rugæ occur under any circumstances. The shape of this part is that of a triangle, its two posterior angles being indicated by the openings of the ureters, and

the anterior or apex by the commencement of the urethra. This is the "*trigone vesical*" of Lieutaud and Camper;* its apex or anterior angle, from being slightly elevated, has also been named "*luette vesicale*," (*uvula vesicæ*.)

Structure. The bladder, like the other hollow viscera, is composed of three coats, or layers, united by cellular tissue. The peritonæal, or exterior coat, we have already noticed as forming a partial investment. The muscular layer consists of pale fibres disposed in different directions. The external fibres on the fore-part may be seen to pass upwards from the neck to the summit, and from thence downwards and backwards to the base of the prostate gland. On the sides they follow an oblique course. The internal set are for the most part transverse, and towards the neck, so nearly assume a circular direction, that some anatomists have considered them as a sphincter muscle, (*sphincter vesicæ*). The mucous coat is pale, and smooth when distended. In early life, the bladder receives its arteries from the hypogastric; in the adult it is supplied by the proper vesical arteries, and by twigs derived from the hæmorrhoidal and internal pudic vessels, the greater number being towards the neck and base. Its veins form a plexus at the same situation, and open into those of the internal iliac. The lymphatics follow a similar course, whilst the nerves come from the sacral plexus, formed by the sympathetic, and also from the two last sacral nerves.

579. *Ligaments of the bladder*. The bladder is retained *in situ* by certain membranous reflexions called ligaments. The fascia iliaca, it will be recollected, descends into the pelvis, becoming adherent to its margin; from thence it is prolonged downwards, to a level with an oblique line extended from the pubic symphysis to the spine of the ischium. At that point it contracts a close connexion with the obturator fascia, after which it is continued to the side of the bladder and prostate gland, with whose structure it becomes in a manner identified. A similar arrangement of the membrane takes place at the opposite side, and both are termed the *lateral ligaments* of the

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* CAMPER, *Fascic. Anat. Pathol.*

bladder. The fascia transversalis (p. 331), it will also be recollected, is continued down behind the pubic symphysis, and on reaching the forepart of the neck of the bladder is reflected on its upper surface. From the point of reflexion two dense fasciculi of fibres, (one at each side of the median line, with a slight cellular interval between them) pass also upon the upper surface of the bladder; these are the *anterior ligaments*. As the peritonæum is being reflected to and from the bladder, it necessarily forms certain folds or duplicatures, which have been termed ligaments. Two of these will be observed extending from its sides to the iliac fossæ, and two posteriorly, corresponding with the course of the umbilical arteries; but, instead of checking its motions, they serve rather as provisions to admit of the changes consequent on distension, and therefore should not be called ligaments.

Male Organs of Generation.

580. The *urethra* is a membranous tube, extended in the male from the neck of the bladder to the extremity of the penis, serving not only as an outlet for the urine, but also for the seminal fluid. Its length has been very differently stated by different persons. It is usually set down as being from nine to twelve inches; but an examination of a considerable number of cases made to determine this point, gave, as the greatest length, nine inches and a half, and the least, seven inches and a half.* Its diameter varies in different parts, being about four lines wide in the greater part of its extent, and from two and a half to three at its orifice.† The tube consists of two structures, one being the mucous lining, continuous with that of the bladder, the other a lamella of cellular membrane, resembling the submucous tissue elsewhere, and which serves to connect it with the contiguous structures found along its course. The

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* WHATELEY, *on the Treatment of Strictures.*

† SIR E. HOME, *Practical Observations on the Treatment of Strictures.*

structures here referred to as enclosing the urethra are the prostate gland, the bulb, corpus spongiosum, and glans penis.

581. The *prostate gland* has been compared to a truncated cone, compressed from above downwards. It more nearly resembles a chesnut, and will be found to enclose part of the neck of the bladder, and the commencement of the urethra, at their junction. The tube, however, is so placed, as that two-thirds of the substance of the gland lies beneath it. The prostate consists of two lateral masses or lobes of equal size, the third being behind and between them. The posterior margin is notched in the middle, and if the vesiculæ be turned forwards, the third lobe, forming a small rounded body, will be found inserted between the two lateral ones, and connected intimately with them.

582. About an inch, or a little less, from the anterior margin of the prostate, the urethra comes into contact with what is called the "*bulb*," which is succeeded by a prolongation, similar in structure, named *corpus spongiosum*, and the latter finally expands into the *glans penis;* so that the canal is invested for three-fourths of its length by a vascular net-work, which, by being differently disposed in different parts, has received the names just mentioned. It consists of a minute interlacement of capillary vessels, connected together by cellular membrane, capable of receiving a considerable quantity of blood, and thereby assuming that state of tension which attends the venereal orgasm. Hence it has been termed "erectile tissue." The bulb is thick, and pendent from the under surface of the canal; the spongy part surrounds it, but exists also in greater quantity along its lower aspect, whilst the glans forms a conical prominence, slightly compressed from before backwards, presenting at its summit a vertical fissure, marking the termination of the urethra (*meatus urinarius*), and bounded at its base by an oblique line. Behind this line is

a constricted portion, or neck, (*corona glandis*) which marks its junction with the rest of the penis.

583. The urethra is considered as being divisible into three portions, which are named according to the structures that surround them, each presenting some peculiarities deserving notice. 1. The *pars prostatica* is the widest part, and from twelve to fifteen lines in length. In the middle of its floor, or lower surface, projects a narrow ridge, from eight to ten lines in length, formed by an elevation of the lining membrane and subjacent cellular tissue. From its shape it has received the name of *caput gallinaginis*, or *verumontanum*. In its middle is the aperture of a large mucous follicle, and close at each side the openings of the vas deferens, and ductus ejaculatorius. External to this ridge the surface is depressed a little into a groove or sinus (*sinus prostaticus*), and is pierced by several minute foramina, communicating with the cells in the substance of the prostate, and through which a viscid fluid is made to ooze if it be pressed. 2. *Pars membranosa* comprises the interval between the margin of the prostate and the bulb, being from ten to twelve lines in length. It is the narrowest part of the canal, and composed of the proper membranes only of the urethra, so hence its name; but it is supported by the terminal expansions of Wilson's muscles, is in close contact with Cowper's glands, and at its extremity passes through an aperture in the deep perinæal fascia. 3. *Pars bulbosa* dilates somewhat at its lower surface, but the diameter of the canal at this point does not exceed that of the following part by more than a line, under ordinary circumstances. 3. *Pars spongiosa* is from six to seven inches in length, and continues uniform in its size, being intermediate in diameter between the membranous and bulbous part, whilst in the glans another dilatation appears to take place, called *sinus navicularis*, previously to its narrowing into the orifice of the urethra. It has lately been contended by M. Amussat, that this dilatation is rather apparent than real,

and that it is owing to the fact that the glans, by its greater firmness of texture, draws the lining membrane outwards with it when the urethra is laid open, thereby making it appear wider than it is in reality, The lining membrane is smooth and lubricated, as mucous surfaces usually are, and several minute foramina will be found to open into it, being the orifices of mucous follicles, or criptæ, placed exterior to it, but lined by delicate processes prolonged from it into their interior.

584. The *corpora cavernosa* form the principal part of the body of the penis, and necessarily determine its form and consistence. They represent two cylindrical tubes, placed laterally with regard to one another, and intimately blended along the middle line for three parts of their length, whilst at the lower part, they branch out into two processes, or crura, so that the whole resembles the letter Y reversed. The crura are attached to the rami of the ischia and ossa pubis, and thence ascend, converging to the forepart of the pubic symphysis, where they become united. Along the middle line a vertical septum exists, which however forms but a partial separation, as it presents, more particularly towards the anterior extremity, many large foramina, which admit of a free communication from side to side. The inferior surface presents, along the middle line, a groove, which partly lodges the canal of the urethra; the anterior extremity is rounded and supports the glans, with whose base it is firmly united. The upper surface, or dorsum, is also marked, but slightly, for the dorsal vein, and is attached to the symphysis by a triangular *suspensory ligament.* This is a dense lamella of fibres, so placed, that whilst the cutaneous border is free, the superior one is attached to the pubis, and the inferior to the body of the penis, where its fibres spread out, becoming identified with its structure.

Structure.—The corpora cavernosa are composed of a fibrous sheath, inclosing a quantity of erectile tissue. The exterior investment is dense and resisting, though composed for the most part of longitudinal fibres. From the inside of its circumference thin lamellæ project, forming partial septa, by which means the cavity is divided into several small cells. Within these is inclosed the intricate vascular interlacement just alluded to, which communicates, on the one hand, with the arteries which run in the interior, as well as with the dorsal arteries, and on the other with the veins, which take a similar course. A transverse section of the body of the penis will shew the relation and connexion of its component parts. On the sides are two cylindrical tubes, formed by a fibrous membrane, inclosing a vascular mass in the interior, and divided along the middle line by a vertical septum; beneath and between these runs the urethra, surrounded by its vascular investment.

585. *Cowper's glands.* These are two small masses, about the size and shape of peas, placed immediately beneath the membranous part of the urethra, and behind the bulb. They consist of several small lobules, united by a membranous investment. Two ducts, from three quarters of an inch to an inch long, issue from them, and proceed forwards, to open into the urethra a little before the bulb. They are retained *in situ*, and supported by a tubular prolongation sent forwards on the urethra from the deep perinæal fascia.

586. The testicles (διδυμοι, *testes*) are the secreting organs of the seminal fluid. The testes, in the earlier months of fœtal life, lie on the psoas muscles, near the lower extremity of the kidneys. Each of them is invested by a proper capsule, or fibrous tunic, and receives moreover a partial covering from the peritonæum, to about the same extent as the kidney does, as both are similarly circumstanced with regard to that membrane. It receives its artery from the aorta, close to which it lies, whilst the vein opens into the vena cava on the right side, and into the renal vein on the left. From its lower extremity its duct will be observed to

descend towards the neck of the bladder; and a fibrous cord of a different character is also extended down through the inguinal canal, to the external surface of the pubic symphysis. This last has been called by Mr. Hunter *gubernaculum testis;* it appears a little broader above than below, and also to contain a minute canal. In the seventh month of pregnancy the length of the gubernaculum is considerably diminished, as the testis has changed its place, having removed from the lumbar region to the iliac fossa. This in strictness cannot be considered a descent: for in the ordinary position of the fœtus, the change is the reverse of that in which its gravity would draw it, and therefore it is rather an ascent. In the eighth month, the testis enters the internal ring, lying behind a process of peritonæum, which makes its exit from the abdomen by the inguinal canal; and at the ninth month it will be found at the bottom of the scrotum, bearing the same relation to its peritonæal investment that it had originally done to the whole membrane, that is to say,—lying behind and exterior to its cavity, but still partially covered by it. This process of peritonæum is an elongated cul-de-sac, somewhat like the finger of a glove, communicating at the inguinal ring with the general cavity of that membrane, and resting on the forepart of the testis and its cord, but closely adherent to both. By degrees its aperture is closed by the narrowing of the ring, and all communication with the abdomen is cut off, after which the part of the process which corresponds with the cord degenerates into cellular tissue, whilst that over the testis remains still a serous cavity. The position and relation of this organ to its serous investment may be illustrated by taking a small bladder, and pressing some elongated body, such as an almond, against its side, so as partially to invert it, the inverted portion being made to serve as an immediate, though partial covering for the substance so placed, as a part must remain unconcealed along the lines of reflexion. This is the way in which the *tunica vaginalis* is derived from the peritonæum, and the position in which the testis is placed with regard to it.

587. Whilst passing through the canal, the testis and cord become covered by the cremaster (p. 193), and at the external ring by the fascia of the cord (p. 324), exterior to which, lie the superficial fascia and the integument. These structures we shall now consider as they are found in the adult.

588. 1. The skin on the pubes is supported by a thick cushion of yellow, adipose matter, and studded with hairs after puberty. From thence and from the sides it is prolonged on the body of the penis, forming a complete and close investment for it, as far as the extremity of the corpora cavernosa; at this point it is continued forwards, forming a loose and unattached fold called *prepuce,* which is intended to protect the glans. The margin of the prepuce terminates in a red line, where it becomes continuous with the mucous membrane. The latter may be traced down to the corona glandis, forming a lining for the prepuce, and thence over the glans to the orifice of the urethra, of whose lining membrane it may be regarded as a prolongation. From beneath the meatus urinarius to the base of the glans, the membrane is thrown into a fold, called *frænum præputii.* In the interval between the root of the penis and the perinæum the integument is distended into a cul-de-sac, intended to contain the testes, and called *scrotum.* Its surface is of a darker colour than elsewhere; it is also thrown into several rugæ, or folds, and marked along the middle line by a slightly elevated ridge or raphé, extending from the penis along the centre of the perinæum to the margin of the anus.

589. 2. The *dartos* is a thin lamella of a peculiar texture, placed beneath the skin, and so disposed as to form two sacks, each containing the testis of the corresponding

side, and both united along the median line so as to form a partition between them (*septum scroti*). This structure is vascular, and striated so as to resemble in some degree muscular fibre. It is confessedly contractile, and serves the purpose of drawing up and sustaining the testes, at the same time that it corrugates the skin; but when macerated, or tried by the usual tests, no trace of fibrine can be discovered in it. When examined with attention it will be found that its texture gradually becomes assimilated to the superficial facia which descends from the abdomen round the cord, and again, below the scrotum, it in the same way passes into the superficial fascia of that region. We may now call to our aid a few facts, which will assist in throwing some light, if they do not actually determine a litigated question. That lamella which lies between the skin and abdominal muscles in the human subject is merely cellular membrane; in the larger quadrupeds a layer of elastic tissue (tissue jaune) is substituted, in order to support the weight of the viscera. In the human subject such a support is not wanted for the abdomen, but the pendulous testes require something of the kind. When emaciation occurs, indicating a general diminution in the sub-cutaneous cellular deposit, the testes hang lower than they had previously done, owing to the absorption of the elastic tissue of the dartos, and its consequent conversion into mere cellular membrane: but when the "embonpoint" is restored, the testes rise to their usual level, by the restoration of the sustaining agent. In this view of the subject the dartos constitutes a transition structure between cellular membrane and elastic tissue.

590. 3. Beneath the dartos, the fascia of the cord and cremaster form an investment which lies on the forepart of the testes. 4. The *tunica vaginalis*, or serous covering derived from the peritonæum, is the next in order. It forms a shut sack inverted on itself in such a way as that

one part of it invests the body of the testis, as well as the epididymis, except where the vessels enter its posterior border, at which point it is reflected outwards, and becomes a lining to the preceding investments, to which it adheres by cellular tissue.

591. The *testes* are of an oval form, somewhat compressed laterally, and so placed by the manner in which they are suspended by the spermatic cords, that their upper extremities are turned obliquely forwards, and the lower, in a corresponding degree, backwards. Along the posterior border of each is placed an elongated appendage, called *epididymis* (επι, *upon*; διδυμος, *the testis*). The testis is inclosed in a dense, firm, fibrous investment, which in a manner determines its form, called *tunica albuginea*. It belongs to the class of fibrous membranes, and is composed of fibres interlacing in every direction. It is of a clear white colour, and is invested externally by the tunica vaginalis. The inner surface is in intimate contact with the proper structure of the testis, being the seminal tubes, and moreover gives off a number of cellular lamellæ which project between them, so as to divide them into several packets or lobules, placed one over the other. Along its posterior border will be observed a narrow line (*corpus Highmori*), which is not unlike the ciliary ligament in the eye. It gives attachment to the cellular lamellæ above mentioned, and serves to support the tubuli as they pass backwards through the tunica albuginea.

Structure.—The proper structure of the testis presents, when its fibrous coat is laid open, the appearance of a pulpy, ash-coloured mass, composed of a number of delicate filaments. Injection with quicksilver demonstrates these to be minute tubes (*tubuli seminiferi*) united by cellular tissue, and coiled upon themselves, so as to form a series of lobuli. According to Munro secundus, who examined the testis with particular attention, a given lobulus (of which there appear to be in all about three hundred) is made up of a continuous canal convoluted on itself, about sixteen feet long, and $\frac{1}{200}$ of an inch in diameter. From these another order of vessels (vasa recta) issue, much fewer in number but larger in size, and placed along the posterior border of the testis, where they ascend somewhat, and open into, or terminate in a new order of tubes still fewer and larger (vasa efferentia), which pierce the tunica albuginea towards the upper extremity of the testis, where, by being somewhat convoluted and united by cellular tissue, they form the head (*globus major*) of the epididymis. The tubes in this part assume rather a peculiar appearance, viz. that of cones (*coni vasculosi*), the summits of which are at their points of exit through the albuginea, and the bases at the upper border of the globus, which they contribute to form by their reflexion. The vasa efferentia terminate in a single tube, which is convoluted as it descends along the posterior border of the testis, where it forms the body of the epididymis; and finally, by a similar disposition lower down, it forms the lower extremity (*globus minor*) of that appendage, after which it ascends along its inner margin, gradually losing its convoluted character, but still resembling a waving line, until it reaches the cord, where it becomes a straight tube, called *vas deferens*, or the excretory duct of the testicle.

592. The *epididymis* is placed along the posterior border of the testes, exterior to its fibrous tunic, and partially invested by the tunica vaginalis. Its upper or larger extremity is called the head, or *globus major*, the lower being named *globus minor;* and the thin intervening part, the body. The head is made up of the vascular cones, the rest of the convoluted vas deferens, which turns up at its lower extremity, and ascends, forming one of the component parts of the spermatic cord. The *vas deferens* lies behind the spermatic artery and veins, and having passed through the inguinal canal, and reached the outer side of the epigastric artery, it suddenly turns away from the vessels just mentioned, and dips down into the pelvis, running along the side of the bladder between its surface and the ureter, then along the inner border of the vesicula seminalis, and

finally, having pierced the prostate, it opens into the urethra at the side of the verumontanum.

593. The *vesiculæ seminales* are two narrow, membranous sacks, placed along the base of the bladder, and extended obliquely from the ureters to the base of the prostate. Their breadth is not more than three or four lines, their length two inches. They converge anteriorly, and diverge behind, so as to include between them an angular space in which the bladder rests immediately on the rectum. Each vesicula is convoluted, so as to appear much shorter than it really is, and consists of two lamellæ, the exterior one being dense and firm, whilst the internal is in every respect similar to mucous membrane, and thrown into folds, so as to divide the cavity into cells. The anterior extremity of the vesicula ends in a narrow tube, which unites with the vas deferens, forming a common duct (*ductus ejaculatorius*). This will be found to run obliquely forwards, lying in the fissure between the middle and lateral lobe of the prostate, then between the latter and the mucous membrane, which it pierces at the side of the verumontanum.

Female Organs of Generation.

594. The genital organs in the female are divisible, like those of the male, into two classes: 1, those of formation (*organa generationis, vel formationis*), consisting of the ovaries, uterus, and Fallopian tubes; and 2, those of copulation, viz. the vagina and vulva. We commence with the latter, as they are usually first examined.

595. *Vulva,* or *pudendum,* is a general term, which is considered as including all the parts perceptible externally. 1. *Mons Veneris.* The integument on the forepart of the pubic symphysis is slightly elevated by a quantity of cellular and adipose substance deposited beneath it, and studded with hair. This part, from its surmounting the labia, has been called mons Veneris. 2. The *labia pudendi* extend downwards from the mons, gradually becoming thinner as

they descend. They form two folds, so placed as to leave an elliptic interval (*rima*) between them, the external part of each being continuous with the skin of the thigh, and covered with scattered hairs, whilst the inner is lined by mucous membrane, forming the commencement of the genito-urinary mucous system. The labia unite both beneath the mons, and before the perinæum, the points of union being called commissures; the inferior one has also received the name of *fourchette*, or *frænulum pudendi*, and the interval between the frænum and the entrance of the vagina has been called *fossa navicularis*. 3. The *Hymen* is a thin, lunated duplicature of the mucous membrane, placed at the lateral and inferior parts of the entrance of the vagina, its concave margin looking obliquely upwards. In the same situation are found, after the rupture of the membrane, some small rounded masses called *carunculæ myrtiformes*. 4. Beneath the upper commissure, and within the labia, is the *clitoris*, a small elongated body, resembling in conformation and structure the diminutive of the penis: thus, it is sustained by two corpora cavernosa, and attached by crura to the rami of the pubis. It is also surmounted by a glans, though imperforate, from which depends a fold of membrane analagous to the prepuce, and acted on by a muscle similar to the erector penis. 5. From the clitoris two folds of mucous membrane descend, in form not unlike a cock's comb. Their inner surface is continuous with that of the vagina, the external insensibly passes into that of the labia. These are called *nymphæ*, or *labia interna*. 6. Between the nymphæ, and beneath the clitoris, is an angular interval called vestibule, at the centre of whose base is situated a circular orifice leading to the meatus urinarius. The membranous fold which surrounds it is rather prominent in some instances, so as readily to indicate its situation. The meatus itself is not more than an inch in length, but its diameter is greater, and more dilatable than in the male. Its direction is obliquely downwards and forwards, being at the same time slightly curved, the concavity being directed upwards towards the pubic symphysis.

596. The *vagina* is a membranous and dilatable tube extended from the vulva to the neck of the uterus, which it embraces; it rests on the rectum, supports the bladder and urethra in front, and is inclosed between the levatores ani. Thus placed, it is oblique from below upwards and backwards, its axis corresponding with that of the outlet of the pelvis. It is also slightly curved, the concavity of the curve looking upwards. Hence its length will be found greater if measured on the lower than on the upper surface. Along the superior, as well as the inferior surface of the vagina, a slightly elevated line extends from before backwards, similar to the raphé in the middle line in other situations. Several transverse lines (*rugæ*) will also be observed, particularly in persons who have not borne children, running at right angles with those just mentioned. The rugæ are but folds of the mucous membrane, and are calculated to admit of the elongation of the vagina that occurs during the ascent of the uterus in pregnancy. The exterior layer of which the vagina is composed is cellulo-fibrous in its structure, and contracts a close connexion superiorly with the fibrous structure of the uterus. It is thin, firm, and of a pale red colour. Round the lower part of the tube a lamella of erectile tissue is placed, which diminishes gradually in quantity from thence upwards, so that near the uterus little or none can be discovered.

597. The *uterus* (*matrix*) is the largest of the genital organs, and is fitted to contain and support the new being, during the period of fœtal life. It lies between the bladder and rectum, above the vagina, with which it is intimately connected, and enclosed in the folds of peritonæum, called the broad ligaments. It is triangular in its form, and presents for examination a fundus, body, and neck, with the enclosed cavity.

The *fundus* is the broad part, which projects above the attachments of the Fallopian tubes surmounting the body; it presents a convex border, and is covered by peritonæum in its entire extent. The *body* tapers gradually as it extends from the fundus to the neck, its two sides being straight, its surfaces however are both convex. At the union of the sides, with the base, are two angles, into which the Fallopian tubes are inserted, the round ligaments being a little before, and the ligaments of the ovaria behind them. The neck is continuous with the body, narrowing gradually to its extremity, where it presents a transverse orifice, (*os uteri, vel tincæ*), bounded by two labia, which are distinguished by their situation into anterior and posterior, the latter being thinner. The cervix is from six to eight lines long, and projects into the cavity of the vagina, which is attached around, at its line of union, with the body of the organ. The *cavity* of the uterus is triangular, and marked into two symmetrical halves by two slightly raised lines, which run along its anterior and posterior walls. At its angles will be observed two minute foramina, which lead into the Fallopian tubes, the lining membranes of which are evidently prolongations of the mucous lining of the uterus. The proper structure of the organ is now almost universally admitted to consist of muscular fibres, disposed, some in the longitudinal, and others in the transverse direction.

598. The *ovaria* are two compressed and irregularly oval bodies, somewhat granulated on the surface, and enclosed between the folds of the broad ligaments. From the lower border of each descends a thin fibrous cord, which attaches it to the angle of the uterus, close behind the insertion of the Fallopian tube. The ovarium is enclosed in a proper capsule, which is a thin cellulo-fibrous membrane; its proper structure presents, when divided, the appearance of a firm, yet vascular mass, giving lodgement to some small vesicles, (*ovula Graafiana.*)

599. The *Fallopian tubes* may be considered as the ex-

cretory ducts of the ovaria, before and a little beneath which they are situated. The attached extremity of each tube is narrow and cord-like, the other is broad, and divided into a number of irregular processes, (*fimbriæ*) one of which is longer than the rest, and attached to the corresponding ovarium. The fimbriated border presents a fissure or opening, (*ostium abdominale*) into which the impregnated ovum is received at the moment of its liberation from the ovarium, and thence conveyed along the tube, which opens into the uterus by another aperture, (*ostium uterinum.*) At this point it may be observed that the serous membrane is in a manner continuous with the mucous, and consequently must be considered as interrupted, inasmuch as there is a real hilus along the fissured edge of the tube.

600. The *round ligament* (*ligamentum uteri teres*) is a cord-like fasciculus of fibres, attached to the angle of the uterus on each side, immediately before the Fallopian tubes. From this point it passes upwards and outwards to reach the internal inguinal ring, and, after having passed through the canal of the same name, reaches the forepart of the pubic symphysis, where its fibres become expanded, and united with the substance of the labium and mons veneris.

601. The *mammæ* are accessory organs to the genital system, and when fully developed after puberty, present the appearance of two rounded eminences, placed on the front of the thorax, resting on the pectoral muscles. In the centre of each projects a small conical body called the nipple, on which several foramina open that lead from the lacteal ducts. A coloured circle, or areola, surrounds the nipple, within which the skin is of a darker tinge than elsewhere. Beneath the skin is deposited, in most cases, a considerable quantity of adipose substance, in which is lodged the proper substance of the gland. This will be found to consist of several lobuli, each being an aggregate of a number of granules. From the granules arise the radicles of the mi-

nute tubes, which receive their secretion, (*tubuli lactiferi;*) and convey it towards the centre of the gland, where they gradually converge behind the nipple, forming larger tubes, (*sinus*). From the latter proceed the ducts which open on the nipple.

602. Though the genital system appears to constitute a most marked distinction between the sexes, its component parts will be found to present so close an analogy in their general conformation, that we can scarcely avoid concluding that both have been formed according to a common type, of which the peculiarities in each constitute so many modifications, dependent on their respective degrees of developement. The analogy between the testes and ovaria is sufficiently obvious in form, function, and organic elements, as well as in their original position, both being lodged in the abdomen. The uterus and the prostate bear a marked similitude, more particularly in the early part of fœtal life, and subsequently, the mode of connexion and relation of the vasa deferentia to the one, resembles that of the Fallopian tubes to the other. The clitoris may be likened to the penis, and the labia to the scrotum, but it should be observed, that the more early the period chosen to institute the comparison, the closer will the similitude appear; at the early part of fœtal life the distinction of sex is not perceptible.

The *peritonæum*, so called from its relation to the abdominal viscera, (περιτεινω *to extend around*) is the most extensive serous membrane in the body, as it not only lines the parietes of the abdomen, but is also reflected over each of the organs it contains, at the same time that it forms several folds of considerable extent. This membrane, in its conformation, may be compared to a shut sack, as it admits neither interruption to its continuity, nor perforation of its surface. It is not easy to assent, on a first inspection, to the truth of the position here laid down, particularly when it is stated, that though the viscera are severally invested by it, and derive their vessels from trunks which lie behind the membrane, still these vessels can reach their destination without piercing its cavity. The fact however is, that certain parts of each organ are left uncovered, and these will be found to correspond with the points at which the membrane is reflected to and from it, whilst the vessels lie between the folds or duplicatures into which it is thrown, by being thus reflected, and so are conducted to their destinations. Were it possible to dissect the peritonæum from off the viscera, as we can from the abdominal parietes, without laceration or injury, so that it would admit of being inflated, it would represent a balloon, and we could give demonstrative proof of its being, as above stated, a shut sack, the viscera being exterior to its proper cavity. Again, by allowing the air partially to escape, we may, as the tension is being relaxed, place the different viscera, with their vessels attached, in their respective situations, so as to give to each its covering, whilst the folds into which it is thrown, as it reflected from one to the other, will serve to lodge and transmit the vessels. This would obviously be conclusive as to the fact; but the delicacy of the membrane is such, and its adhesion to the viscera so intimate, that it is impossible to detach it to any extent, which constrains us to resort to the expedient of tracing successively its folds and reflexions, so as to shew its continuity throughout, knowing, that from whatever point we start, we shall ultimately reach the same again, just as we would when tracing the circumference of a circle. To attain the end here indicated, several modes of proceeding have been adopted from time to time, each possessing, no doubt, some advantages. The following will be found to suffice for the attainment of the proposed end; whilst pursuing it, we shall consider the membrane as divisible into three zones, or portions, corresponding with the regional division of the abdomen, which has been indicated (p. 318). It may not be amiss, previously to entering on this proceeding, to point out the way in which the membrane should be exposed and exhibited. After the abdominal muscles have been dissected, the transversalis should be carefully separated, commencing over the iliac region, and so proceeding up to the costal cartilages, and backwards, deeply into the lumbar region. The same should be done at the opposite side; but, along the middle line, part of the aponeurosis must be allowed to remain, in consequence of its firm adhesion to the membrane. When these preliminaries have been adjusted, a transverse incision may be made from the costal cartilages at one side, across to the opposite, and a second from one crista ilei to the other. These will include the middle zone of the membrane, which we shall trace first, leaving the others untouched.

A. The *umbilical* portion of the peritonæum lines the inner surface of the muscles, and if traced backwards, into the right lumbar region, will be found, after passing in front of the kidney, to come into contact with the posterior surface of the colic vessels, along which it is reflected to the ascending colon, investing it for three-fourths of its circumference, and so reaches the anterior surface of its vessels, on which it is, as it were, guided in front of the spine and the large vessels, until it reaches the root of the mesenteric artery. There a change of direction occurs, for the membrane is reflected along that artery and its branches, to the small intestines, (jejunum and ileum,) which it coils round to reach the under surface of the vessels, and so to pass back again to the point of reflexion, thus forming the *mesentery*. From the base of this fold we follow the membrane into the left lumbar region, where it is similarly disposed round the left colon and its vessels, as at the opposite side, and having reached the abdominal parietes, it lines them even to the umbilicus, whence we set out. Thus we find on either side two folds, (*meso-cola*,) which bind the corresponding parts of the large intestine along the lumbar regions, and inclose the colic vessels. The large duplicature, (the *mesentery*,) corresponds by its greater circumference with the whole length of the jejunum and ileum, to which it is conducted by the mesenteric vessels, which it incloses, together with the lacteal absorbents and their glands, whilst its base or point of reflexion extends obliquely across the spine, from the left side of the second lumbar vertebra, down to the right sacro-iliac symphysis. Previously to commencing the examination of the lower division of the peritonæum, it may be well to mark off the part already inspected, by drawing a line across it on the spine, and another at each side in the iliac fossæ.

B. The hypo-gastric portion of the membrane is differently disposed along the middle line from what it is on the sides, so that each part must be reviewed separately. To facilitate its examination, it will be found convenient to insulate, by two perpendicular incisions, the middle strip, which corresponds with the recti muscles, and reflect it downwards. Commencing over the spine, where it is continuous with the part marked A, we trace it over the promontory of the sacrum, and in front of the rectum, from whose sides it is reflected back to the sacrum, forming a fold, (*meso-rectum*,) which lodges the hæmorrhoidal vessels. The membrane will be found to rest on the rectum until it arrives opposite the base of the bladder, where it turns forwards, guided by the ureters, on which it is folded into duplicatures, *plicæ semi-lunares*, or posterior *false* ligaments of the bladder, and limited on the sides by the vasa deferentia. It thus invests the posterior surface of the bladder as far as the points at which the urachus and umbilical cords are reflected away from it to the abdominal parietes; guided by these, and at the same time thrown into three falciform folds, the membrane passes upwards behind the recti muscles to the umbilicus, where it is again continuous with the part A, or at least was continuous before we had severed their continuity by an incision. The lateral or iliac division of the membrane is continuous with the umbilical portion, and extends thence downwards over the front and sides of the cœcum, and its appendix, investing the latter all round, and forming a falciform process along its border. Having lined the iliac fossa, it is reflected from its lower margin upwards, behind the abdominal muscles, where it again passes into the part A. In the space between the margin of the pelvis and the side of the bladder a duplicature will be observed, (lateral *false* ligament,) which is owing to the fact, that the membrane is attached on the sides to two prominent points, and must necessarily be thrown into a transverse fold extended across the interval. It is scarcely necessary to add, that a similar distribution takes place at the opposite side. In the female, the arrangement of this part of the peritonæum differs from that in the male in some particulars. After having invested the front and sides of the rectum, it is reflected on the posterior surface of the neck of the uterus, and somewhat also on the vagina; it covers also the fundus and anterior surface of that organ, from which it passes to the base of the bladder. Now, by being extended from the sides of the uterus to those of the pelvis, it forms, on the principle above indicated, two folds, (*ligamenta lata uteri, vel alæ vespertilionum*). These, it will be observed, together with the body of the uterus, form a transverse septum, dividing the pelvis into two compartments, of which the anterior contains the bladder, and the posterior the rectum. The upper border of each of these presents two lesser folds; the anterior, or larger one, contains the Fallopian tube, whilst the posterior lodges the ovarium.

C. The superior, or *epigastric* division, is much more complex in its arrangement than the others, and more difficult to be described without the aid of diagrams, or ocular demonstration. Like the lower division, its distribution along the middle line differs from that at the sides, and moreover, each lateral portion presents certain peculiarities. The extent to which the part A has been examined, being noted or marked by drawing a line across the root of the mesentery at the spine, we may commence to trace the membrane upwards from this point, the continuity being there obvious. We shall then find that it passes forwards to the transverse colon, becoming adherent to its under surface, but is soon reflected downwards to the bottom of the abdomen, forming the posterior layer of the great omentum, and by folding back, again answers to the anterior layer of the same, even to its line of attachment, along the great curvature of the stomach. On reaching this viscus, the membrane covers its anterior surface as far as the lesser curvature, where it is reflected upwards to the liver, and guided by the vessels to its transverse fissure. We trace it thence to its upper margin, the umbilical ligament interposing, and as the latter passes obliquely down to the umbilicus, so does the membrane, thus becoming continuous with the part (A). By being thus checked in its ascent by the ligament, it folds round it, and then extends upwards in the interval, between the diaphragm and liver, becoming attached to both along the middle line, and is thence reflected outwards in continuity with the part that lines their contiguous surfaces. The fold thus formed is called the *falx* or *falciform process.*

Having in this way shewn a continuity of surface along the middle line, it will be found convenient to take a different mode of proceeding, in order to shew the way in which the liver is invested, and also the formation of the greater and lesser epiploons, as well as of the aperture (*foramen of Winslow*) which leads down into the cavity of the former. With this view we commence at the umbilicus; and having marked off a narrow strip of the membrane, about three inches in breadth, we trace it upwards behind the recti muscles to the diaphragm, being gradually checked and folded on the umbilical ligament, which retains the point of reflexion on a line with the lower surface of the liver, whilst the reflected layers are in apposition with one another, and continued up between the diaphragm and liver, gradually narrowing to a point at the upper border of the latter. The *falx* thus formed is continuous by its borders with those parts of the membrane that line the contiguous surfaces of the diaphragm and liver, whilst its base passes down on the lower surface of the latter to its transverse fissure, where it is arrested by the vessels, and reflected down upon them, forming the upper layer of the lesser omentum. So far for the narrow strip which is disposed along the middle line; we may continue to follow it down to the stomach, and over its surface to the great curvature, from which it is prolonged loose and unattached, forming the upper, and afterwards the under layer of the great omentum, as already indicated, when tracing it from below upwards. We may follow it, in the next place, to the transverse colon, and thence down to the spine, where it becomes united with the part (A) at the root of the mesentery. We shall, however, suspend this proceeding, until we have traced the two lateral parts to the same point, viz. the front of the hepatic vessels.

Commencing, then, a little to the left of the umbilicus, we follow the membrane behind the costal cartilages, and along the under surface of the diaphragm to the deepest part of the left hypochondriac region, where it meets the œsophagus, on which it is reflected down to the great curvature of the stomach, where it is arrested by the vasa brevia, and by them guided to the spleen, and reflected over its surface, from which it returns towards the stomach again, where it becomes continuous with the left border of the great omentum. In the interval between the œsophagus and falx, the membrane passes over the surface of the diaphragm down to its lower border, over which it descends to the transverse fissure, and so to the lesser omentum. Now, at the right side, the membrane, after lining the diaphragm, passes upon the upper surface and right border of the liver, and having passed over its lower margin, we trace it upon the concave surface of that organ, where it invests the gall-bladder, and so reaches the right margin of the vessels, where it forms a rounded border by being folded so as to become blended with the part already traced on their upper surface, and also with that which lines the under one. Let us then take up the latter also at this point, noting the point at which we do so, and we shall find,—first, that the upper layer of the lesser omentum, after passing in front of the stomach, and forming the upper and under layers of the great omentum, becomes attached to the transverse colon, and finally, after forming the inferior lamella of its meso-colon, becomes continuous at the root of the mesentery with the part (A); and secondly,—that the under layer, after having passed through a complete labyrinth, will lead us back again to the posterior lamella of the lesser omentum, from which we began to trace it, thus shewing a continuity in every direction. The two lamellæ of the lesser omentum (the hepatic vessels interposing) proceed down to the lesser curvature of the stomach, where they separate and pass, one before the other, behind that organ, until they reach its great convexity, where they again come into contact, after having inclosed the epiploic vessels. Placed thus in apposition, the two lamellæ descend to the bottom of the abdomen, where they are reflected back on themselves as far as the transverse colon, and so form the *great omentum*. On reaching the colon, the returning layers diverge and inclose it, one passing before, the other behind it, after which the latter (the inferior one) is directed back to the spine, forming the *under layer of the transverse meso-colon*, and, at the root of the mesentery, is continuous with the portion (A). But the other, namely, that which lies before the colon, inclines obliquely upwards, forming the *upper layer of the transverse meso-colon*, and proceeds in front of the transverse part of the duodenum, the pancreas, the great vessels, and crura of the diaphragm, from which it is reflected to the surface of the liver, which it invests as far as its transverse fissure, where it descends behind the vessels to the point from which we set out.

Having already indicated the mode in which the falx, or great suspensory ligament of the liver is formed, it remains only to add, that at the point at which the peritonæum is reflected from the diaphragm to its upper border, three folds are formed, one in the middle, called the *coronary ligament*, the others at the sides, named *lateral* ligaments. The *great omentum* is the broad floating process of peritonæum that lies loosely over the forepart of the small intestines. It consists, at the lower part, of four lamellæ, that is to say, below the transverse colon, inasmuch as its two posterior layers go to form the transverse meso-colon. The *lesser omentum (epiploon hepato-gastricum)* extends from the transverse fissure of the liver to the concave border of the stomach, enclosing the hepatic vessels. At its right margin, the membrane is folded so that both surfaces are continuous, whilst the left extends over to the œsophagus.

It has already been observed, that it is difficult at first sight to conceive how the different vessels can reach the viscera without piercing the peritonæum, though the trunks from which they proceed lie behind them. The aorta lies on the spine, behind the peritonæum; the kidneys, placed at the sides, are also behind that membrane; there, therefore, can be no difficulty in perceiving how their vessels reach them. The mesentery, consisting of two lamellæ, is reflected from the spine close to the origin of the superior mesenteric artery, which is thus placed between its layers. The inferior mesenteric artery, after running behind the peritonæum to the pelvis, lies between the sacrum and rectum, in the fold of the meso-rectum: the colic vessels are inclosed in the meso-cola. It remains for us first to consider, how the cœliac axis and its vessels lie with regard to the membrane, which can only be done with effect by examining the formation of what is called Winslow's foramen, which, properly speaking, is a canal, or tube, not a perforation, as the term foramen would imply. If the finger be passed close by the neck of the gall-bladder, beneath the free border of the lesser omentum, the two lamellæ of the lesser omentum, with the hepatic vessels enclosed, will lie upon the finger, and the ascending layer of the transverse meso-colon behind it. If an effort be made to pass the finger down behind the stomach, it is at once checked by the manner in which the membrane is there reflected backwards and upwards. Just below the point of reflection stands the cœliac axis, so that its hepatic and coronary branches, by passing over this reflected part, can get between the layers of the lesser omentum, and so reach their destinations. Now, the splenic artery runs along the pancreas, which has been shewn to be posterior to the ascending layer of the transverse meso-colon; but on reaching the spleen, it insinuates itself between the layers of its epiploon.

The *foramen of Winslow* is an oval tube, by which the general cavity of the peritonæum communicates with that enclosed within the great omentum: it lies between the lesser omentum and the returning lamella of the transverse meso-colon. By inserting a large blow-pipe into it, air may be passed down into the omental sack, shewing that it consists of a double pouch, one inside the other, and which, therefore, when collapsed, will appear to consist of four layers. Now let it for a moment be conceived possible, by passing down a hook to seize the inner pouch, and draw it upwards, it will necessarily be inverted, as it is being drawn through the foramen into the general peritonæal cavity, where it will appear as a long cul-de-sac. If such a measure could be effected, the hepatic and coronary arteries, it is obvious, could pass readily to their destinations, as the membrane no longer interposed. Suppose them to have reached their destination, we may then commence to invert the sack previously drawn out, upon itself, and so turn it inside out, until it is completely inverted, at the same time thrusting it down to its original situation; it would then be found that its upper extremity would represent a narrow neck or tube, with a throat-like aperture, such as we find Winslow's foramen to be.

The Perinæum.

603. In this region the following muscles are situated: the sphincter ani, and accelerator urinæ, which may be considered as single muscles composed of symmetrical halves; also the transversus perinæi, erector penis, levator ani, and compressor urethræ, disposed in pairs on each side of the median line.

604. The *sphincter ani* is a flat elliptic muscle, placed immediately beneath the skin surrounding the margin of the anus. It is attached posteriorly to the coccyx by a narrow fasciculus of tendinous fibres, and anteriorly becomes blended, about midway between the anus and the bulb, through the medium of a common tendinous point,

with the transversi and acceleratores muscles, whilst the intervening part is disposed like orbicular muscles elsewhere, being composed of fleshy fibres curving round the intestine, and united by commissures before and behind it. One surface of the muscle is covered by the skin, the other rests on some cellular tissue, which separates it from the internal sphincter and levator ani.

605. The *transversi perinæi* are two narrow fleshy fasciculi, which converge to the central point of the perinæum as their common destination. They arise on each side from the inner and forepart of the tuberosities of the ischia, and proceed, inclining forwards, to the point just indicated, where they are blended with the sphincter ani and acceleratores urinæ. Two muscles of this name are sometimes found on either side.

606. The *accelerator urinæ* (*bulbo-cavernosus*) is so disposed as to surround the bulbous part of the urethra. We may consider it as a single muscle consisting of two symmetrical halves, united so as to form a tube surrounding a part of the urethra, and connected anteriorly, by two diverging processes, with the corpora cavernosa, posteriorly, at the central point of the perinæum, with the sphincter and acceleratores, whilst its inferior fibres are extended obliquely outwards to the rami of the pubis. Its analogy with the sphincter vaginæ would lead us to consider it in this way. In conformity with usage, however, we shall describe each lateral half separately. The fibres of the muscle, forming a thin, flat plane, are blended with those of the corresponding muscle along the middle line, beneath the bulb of the urethra. Their junction extends forwards for three quarters of an inch from the tendinous point above referred to. The fibres from this line of origin proceed in three different directions; the inferior set pass obliquely outwards, and are attached to the angle of union formed by the deep perinæal fascia with the ramus of the pubis; the anterior set incline upwards and

outwards, to be inserted into the corpus cavernosum; whilst the intervening or middle fibres turn round the canal of the urethra, and become tendinous on reaching its upper surface, upon which they unite with those of the corresponding muscle, thus forming a tube. If an incision be made over the bulb, so as to cut through the fibres of the muscle, and if one half be then carefully reflected outwards, its points of attachment will be readily seen; after which, if the urethra be cut across, and reflected downwards, the union of the middle part of the muscle on its upper surface will be brought into view.

607. The *erector penis* (*ischio-cavernosus*) is a flat, thin muscle, resting on the crus penis and corpus cavernosum. It arises from the inner side of the tuber ischii, from which its fleshy fibres proceed obliquely upwards and inwards, and become tendinous on reaching the corpus cavernosum, into whose fibrous sheath they are inserted. The inferior surface of the muscle is covered by the skin and fasciæ; the superior is in contact with the crus and body of the penis, whilst, between its inner margin and the accelerator, a groove exists, in which the superficial perinæal artery is lodged.

608. The *levator ani* is a thin broad muscle, placed obliquely across the outlet of the pelvis, which it assists in closing. Its origin cannot be distinctly stated without making reference to two membranes between which it is placed, and from whose line of union most of its fibres are derived. The obturator internus muscle occupies the whole space from the internal border of the obturator foramen to the sciatic notch. The upper half of this muscle is lined by the pelvic fascia, prolonged down, as has been already stated, as far as to a line extended from the symphysis pubis to the spine of the ischium, where it is reflected upon the levator ani, which guides it to the side of the rectum and bladder. The lower part of the obturator muscle is also covered by a fascia, but more dense and

firm than the preceding, which is extended upwards upon it from the thin, or falciform edge, of the great sciatic ligament, of which it may be regarded as a prolongation. This fascia becomes united to the fascia pelvica along the line above indicated, and may be said to determine its point of flexion; and from the angle which they form by their union, arises the middle part of the levator ani. This fact may be easily ascertained by dividing the obturator fascia for an inch, or a little more, and then passing a probe between it and the obturator muscle. It will then be found, as the instrument is being moved backwards and forwards, that the greater part of the levator ani is attached only to these membranes. The muscle then arises, anteriorly, from the pubis, near its symphysis, and immediately above its arch—posteriorly, from the spine of the ischium, and along the intervening space from the angle formed by the union of the obturator and pelvic fasciæ. From this extensive origin the fibres proceed downwards and inwards, the posterior set being fixed to the side of the coccyx; those next them in order unite by a raphé with the corresponding muscle, in the interval between the coccyx and the margin of the anus; the middle fibres are inserted into the extremity of the rectum, becoming connected with those of the internal sphincter, and the anterior ones pass on the side of the prostate, some of them uniting with those of the corresponding muscle beneath the membranous part of the urethra. In the female, the fibres of this muscle, previously to reaching the rectum, descend by the vagina, and become intimately connected with it.

609. The *compressor urethræ* (Wilson), *compressor prostatæ* (Soem.), is a narrow fasciculus that arises close by the pubic symphysis, immediately before the anterior fibres of the levator ani, and from which it is merely separated by a small vein and a little cellular tissue. The muscle descends close to its fellow of the opposite side, and beneath the membranous part of the urethra, both of

them having become tendinous, unite, so as to support it in a sling.

610. The perinæal muscles in the female correspond so nearly with those of the male in their number, general conformation, and attachments, that it is unnecessary to treat particularly of more than two of them.

611. The *erector clitoridis* (*depressor,* Meckel) resembles the diminutive of the erector penis; it arises from the ramus of the pubis, and is inserted into the body of the clitoris.

612. The *constrictor vaginæ* resembles an orbicular muscle, being composed of two narrow fasciculi, united before and behind the vagina by two commissures, and leaving between them an elliptic interval corresponding with its circumference. The two muscles of this name may be said to arise posteriorly at a point common to them, with the sphincter ani and transversi muscles; and after diverging to enclose the vagina, they unite in front of it into a tendinous process, which connects them to the corpus clitoridis.

Actions.—The transversi muscles conspire to fix the common point of attachment of the perinæal muscles, and so increase their power. The action of the sphincter ani is sufficiently obvious. The accelerator muscle, by surrounding the bulbous part of the urethra, and by the increased power it acquires from its many points of attachment, is enabled forcibly to propel any fluid that may be lodged within the canal in that situation. The levator ani, in position and direction, is opposed to the diaphragm, and as the latter forces down the intestines by its descent, the former, as its name implies, can elevate at least the lower part of the intestinal canal.

The Internal Pudic Artery.

613. The parts contained in the perinæum are supplied with blood from the internal pudic artery. This vessel usually arises as a distinct branch from the internal iliac

artery, but occasionally is derived from a trunk common to it and the ischiadic. It inclines downwards and outwards to reach the spine of the ischium, lying at first on the sacral plexus, but afterwards passes between the pyriformis and coccygeus muscles, to gain the point just referred to. Having thus passed out of the pelvic cavity, it rests upon the external surface of the spine of the ischium, beneath which it returns into the pelvis again by the lesser sciatic notch, and proceeds towards the inner surface of the tuber ischii. In this situation it lies on the obturator internus muscle, to which it is bound down by the obturator fascia, between which structures it lies, in its course forwards and upwards, along the rami of the pubis and ischium, towards the pubic arch. On approaching the latter, the artery pierces the fascia, and becomes placed between the crus penis and the bone, where it divides into its two ultimate branches, viz. the dorsalis penis, and the artery of the corpus cavernosum. In this course numerous branches are given off; we may divide them into three sets, viz. the pelvic, the perinæal, and the terminal. The pelvic branches consist merely of several small ramusculi given to the coccygeus, pyriformis, and obturator muscles, and also some equally unimportant, which pass inwards to the rectum and prostate. The perinæal branches are the following:

1. *Arteriæ hæmorrhoidales externæ* incline inwards from the pudic artery, when it has reached the tuber ischii, and must necessarily pierce the fascia which binds it down, in order to reach the perinæum. They lie embedded in a quantity of adipose substance, lodged in the interval between the ischium and the sphincter ani, and soon branch out into ramusculi, which are distributed to the parts about the margin of the anus.

2. *Arteria perinæa superficialis* pierces the fascia a little higher up than the preceding; and then turns upwards close by, and parallel with, the rami of the ischium and pubis: it crosses over the transversus perinæi muscle, and finally lies in the groove

between the erector penis and accelerator urinæ. In this course, it gradually becomes superficial as it ascends, and in the male is distributed to the scrotum, in females to the labium. It not unfrequently gives off the following artery.

3. *Arteria transversa perinæi* arises either from the pudic artery, or from the preceding branch, when on a level with the transversus perinæi muscle. As its name implies, it runs across the perinæum, and terminates in small twigs, which are distributed to the parts between the anus and bulb.

4. ——— *corporis bulbosi* passes horizontally inwards from the pudic artery, when it is on a level with the bulb of the urethra, on reaching which it divides into ramusculi, that soon become capillary, and spread out into the erectile tissue, constituting the bulb and corpus spongiosum.

5. ——— *corporis cavernosi* is one of the terminal branches of the internal pudic. It turns forwards, and enters the body of the corpus cavernosum, in which it ramifies somewhat in the same way as the preceding vessel does in the corpus spongiosum and bulb.

6. ——— *dorsalis penis* passes upwards between the root of the penis and the pubic symphysis, and having pierced the suspensory ligament, runs forward parallel with its fellow of the opposite side, freely supplying the integument in its course. Near the corona glandis each of these arteries branches out into ramusculi, some of which pierce the glans, whilst others supply the prepuce.

614. The *internal pudic vein* corresponds in its course and distribution with the artery just described. It commences by branches which are placed along the inferior and lateral parts of the penis, communicating at their origin with the capillary arteries of the glans, and in their course with those of the corpus cavernosum. At the pubic symphysis these are joined by others which issue from the corpus cavernosum; after this the vein takes the course of the artery, receiving branches, and gradually increasing as it descends inside the ramus of the ischium and its tuberosity; and, finally, after having passed round

the spine of that bone, it terminates either in the sciatic, gluteal, or obturator vein.

615. A vein of considerable size runs on the dorsum of the penis (*vena dorsalis penis*). It commences by small branches, which, at the corona glandis, communicate with its capillary arteries, and proceeding backwards, receives branches of anastomosis from the pudic vein, and also from the interior of the corpus cavernosum. On reaching the root of the penis, it passes beneath the pubic symphysis, and terminates in a venous plexus placed at the neck of the bladder, through the medium of which its blood is finally conveyed into the internal iliac vein. The dorsal vein is sometimes found a single vessel, at others, double, or even triple.

616. The *pudic nerve* is a branch of the sacral plexus, from which it inclines downwards and outwards, so as to come into contact with the artery of the same name, as it is escaping from the pelvis, in the interval between the pyriformis and coccygeus muscles. Its course and distribution are similar in every respect to that of the artery. Thus it sends one or two hæmorrhoidal branches to the extremity of the rectum, also twigs to the obturator muscle, and a long branch which accompanies the superficial perinæal artery, and has a similar mode of distribution. The continuation of the nerve reaches the dorsum of the penis, by passing between the corpus cavernosum and the pubic symphysis; after which it passes forwards beneath the skin as far as the glans, where its filaments cease to be discernible. In the female the superficial perinæal nerve is larger than the deep-seated one just described, because it is distributed to the labium, whilst the other supplies the clitoris.

Dissection.—We shall examine the perinæum as a surgical region, and review the different parts it contains in reference to the operation of lithotomy, or more properly cystotomy (*κυστις, a* *bladder; τεμνω, to cut,)* as well as to catheterism. By the term perinæum is understood the triangular interval included between the rami of the pubis and ischia, its apex corresponding with the arch of the pubis, and its base with a line extended from one tuber ischii to the other. When viewed externally, this restricted space is observed to be divided into two equal parts, by a continuation of that vertical line which indicates the original division of the body into two symmetrical halves, and which here, as elsewhere, is called the raphé. From a little below the fold of the scrotum, an incision may be made through the skin along the raphé, down to the margin of the anus. At its upper extremity, a transverse incision may be made, extending outwards, on the thighs, at each side, for two inches. The flaps of integument may, in the next place, be reflected outwards to the flexures of the thighs, and pinned back. By raising the integument round the anus, the sphincter muscle will be exposed. The superficial fascia, which is, in fact, nothing more than the sub-cutaneous cellular tissue, having been exposed, its attachments and mode of distribution deserve attention. If it be divided along the middle line, and carefully reflected to each side, it will be found firmly attached to the rami of the ischia and pubis. If traced upwards, or if air, or a jet of water be passed beneath it, it will be found to be continuous with the sub-cutaneous investment of the scrotum; viz. the dartos, and also with the superficial fascia of the abdomen. A little below the transversus perinæi muscle the superficial fascia will be observed to pass back, and become identified with the deep-seated fascia, after which both may be traced beneath the superficial sphincter. When extravasation of urine takes place into the perinæum, the attachments of this fascia will influence the direction in which the fluid proceeds, should its quantity increase. Though its natural tendency is backwards to the anus, or downwards along the inside of the thighs, its progress in these directions is interrupted by the adhesion of the membrane to the rami of the ischia and pubis at each side, and to the deep fascia posteriorly; but towards the scrotum, no impediment exists, and so we find that effusions gradually make way upwards to the groin, or even on the front of the abdomen, their progress being preceded by a red erysipelatous blush on the skin. The superficial fascia being drawn aside, and pinned back on the reflected integument, the superficial perinæal artery will be found running in the angular interval between the accelerator urinæ and erector penis. Midway between the margin of the anus and the bulb of the urethra a narrowed point exists, which forms the common centre of the perinæal muscles: to it converge the transversi muscles from the sides, and the sphincter from behind, and from it the lower fibres of the acceleratores diverge. The last named muscles may be divided along their raphé, or common line of junction, and reflected carefully outwards, so as to expose the bulb, which will be found invested by a thin, smooth lamella, prolonged upon it from the margin of the deep perinæal fascia, through which the canal of the urethra must necessarily pass, when emerging from the pelvis into the perinæum.

The *deep perinæal fascia* is a thin, yet firm membrane, which fills up the interval between the rami of the pubis and ischia, so that it is thereby rendered triangular in its form. In its mode of attachment and general characters it presents some similitude to the obturator fascia, which fills the foramen of that name. It should be observed, that this structure has been variously denominated by different writers. Camper* and Douglas named it *ligamentum triangulare*. M. Velpeau† has devised or adopted the term *recto-vesical aponeurosis*. The terms ligament, tendon, aponeurosis, and fascia, appear to be ordinarily used, as if they were synonymous. It would be well to confine each of them to particular forms of structure. A ligament is properly a fasciculus of tendinous fibres connecting bones, and for the most part entering into the formation of joints; a tendon is the cord-like prolongation of a muscle; an aponeurosis is the expanded fibrous lamella prolonged from a broad muscle; whilst the term fascia, in strictness, denotes a membrane serving to invest parts, or to support them. In this sense we here apply the term to the fibro-cellular lamella which fills up the outlet of the pelvis, and assists in supporting its viscera: it is also called the deep fascia, to distinguish it from the superficial one already noticed.

The deep perinæal fascia is attached on each side to the osseous boundaries of the perinæal space, which thus determine its form, and if examined beneath the pubic arch, will be found to consist of two lamellæ, which, on approaching the base of the sub-pubic ligament (p. 174,) separate, one passing on its cutaneous, the other on its pelvic surface, where they terminate, by gradually becoming thin and cellular. Where the membrane is strained across the interval between the bones, it at first sight appears to terminate by a lunated border, whose concavity looks towards the rectum; but we find that its continuity is not interrupted at this point, as it can be traced downwards round the margin of the rectum, and on the levator ani, gradually, however, becoming thin and indistinct. About half an inch below the base of the sub-pubic ligament, and, therefore, an inch below the arch, the membrane presents a foramen peculiarly formed for the transmission of the urethra. If the latter be drawn forwards, it will be found to be invested by a tubular prolongation derived from the margin of the foramen, and continuous with the perinæal or external lamella of the fascia. A similar prolongation is reflected backwards from the posterior or pelvic lamella which invests the membranous and prostatic portions of the canal, and extends as far as the neck of the bladder. When the parts remain undisturbed, the surface of the fascia is quite flat; and if the urethra be cut across close to it, the aperture will be found barely sufficient to transmit it. But if the penis be drawn obliquely upwards, the fascia is rendered tense, and convex forwards, by means of the traction excited on it through the medium of its tubular prolongation. Should the experiment be then made of cutting off the urethra close to the fascia, the foramen will be found much wider, for the tube had been previously rendered, as it were, trumpet-shaped, and so it will be when the urethra is rendered tense during the introduction of a catheter. It may now be observed, that the urethra, whilst the penis remains pendulous, forms two curves, the concavity of one looking down towards the perinæum, that of the other towards the arch of the pubis. The first of these is owing to the fact, that the penis is attached on each side of the arch of the pubis by its crura, and by its triangular ligament to the symphysis, from which it hangs downwards, carrying the urethra with it. From the angle thus formed by the body of the penis with the forepart of the pubis, the urethra has to descend more than an inch, to get to a level with the urethral foramen in the perinæal fascia; and, finally, having passed through the foramen, it inclines a little upwards behind the symphysis. This latter curve is very trifling in the adult, but is considerable in the young subject, owing to the position of the bladder. When, preparatory to the introduction of a catheter, the penis is drawn upwards on a line with the abdomen, the first or anterior curve no longer exists, and so the canal presents but a single curve, corresponding with that of the instrument. If the integument, superficial fascia, and muscles, be removed from the penis and perinæum, we can observe what takes place on the introduction of a catheter. No impediment occurs during its passage through the spongy portion, as it is called, for that part of the tube is supported by the body of the penis, and is also quite straight. But the bulbous portion is comparatively unattached, and also slightly dilated at its lower surface. On arriving close to the perinæal fascia, should the point of the catheter deviate to either side, or be elevated or depressed too much, it will miss the foramen, carrying the urethra with it, and so the latter will be pinched between the margin of the foramen and the instrument. If, in such a position of the parts, force be used, or if the catheter be depressed, with a view to make it correspond with the curve of the urethra, the latter must be torn through, or considerably injured. A catheter, in its construction, resembles an angular lever, though not intended to act as such: but it virtually becomes such, if, after its progress is impeded, and it is thereby rendered fixed, an effort is made to depress the handle; for then the beak is made to move in the opposite direction, and will readily tear through the urethra. The effect of drawing the penis upwards may be exemplified in this way; when the catheter has reached the bulb, (the urethra and perinæal fascia being fully exposed) if it deviates to either side, the point will be observed to catch on the margin of the foramen, but if the urethra is drawn upwards, the impediment will be removed by the widening of the aperture in the foramen. It has been contended rather strenuously by some persons, that the direction of the urethra becomes horizontal, and its canal straight, when the penis is drawn directly forwards. It will however be found, that when the penis is so placed, the urethra has to descend more than an inch to reach the urethral foramen, after which it turns somewhat upwards. Moreover, the part of the urethra between the root of the penis and the neck of the bladder will be found loose and relaxed, no matter with what degree of force the penis be drawn forwards, for that will affect only the part of the urethra which corresponds with the body of the organ, as must be evident when the attachments of the latter to the bones, by its suspensory ligament and crura, are considered. The tension will, by these attachments, be confined to the spongy portion of the canal, and cannot be propagated thence to the bulbous or membranous. This constitutes an objection to the use of straight catheters.

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* *Fasciculi Anatomico-pathologici.*

† *Anatomie des Regions.*

The empirical lithotomists were in the habit, when introducing a catheter, of directing its curve downwards, and so passing it on until it reached the bulb, when they rotated the handle of the instrument upwards, so as to turn its cavity towards the pubic arch, at the same moment pushing it into the bladder. This manœuvre, which was termed "tour de maître," formed part of a system of evolutions calculated to throw an air of importance over their proceedings, at the same time that, by rendering even the first step of the operation difficult, it contributed not a little to secure to themselves the profits arising from its performance. If, after laying bare the urethra and the fascia, as above directed, a catheter be passed down, with its concavity turned towards the perinæum, we shall find that as the turn is being made, the point of the instrument will describe an arch of a circle, carrying the urethra with it round the margin of the urethral foramen. Whilst this movement is made, if the urethra be kept perfectly tense, no impediment will occur to the passage of the instrument; but it should be observed, that at that moment the attention of the operator is divided between two objects, viz. the rotation of the instrument, and the keeping of the urethra tense, so that it usually happens that the latter is forgotten at the moment that it should be most vigilantly attended to. On this account it is that the manœuvre is found so difficult of execution, as it requires a consentaneous action of both hands, which can be attained only by considerable practice. But it really does not facilitate the introduction of the instrument in the slightest degree; and if the motion of its point be carefully watched at the time that the turn is being made, it will be difficult to come to any other conclusion than this,—that its only effect is an injurious one; for, to use a homely phrase, it but gives the point of the instrument an opportunity of going astray.

Having noticed the boundaries of the perinæum, considered as a surgical region, and having enumerated the different structures included within it, as well as their mutual relations, we may now observe, that narrow as that space is, there is scarcely a direction possible to be conceived in which it has not been traversed by incisions made to open a way through it to the bladder for the extraction of calculi. Taking these different modes of proceeding in their historical order, the first we find recorded is that of Celsus*, which furnishes a striking proof of the imperfection of surgical apparatus at the time in which he wrote. The patient was placed in the lap of an assistant, who was required to keep his legs bent so as to expose the perinæum. If the patient was large, or very robust, two assistants were strapped together by the thighs, and each held the leg next to him, whilst the body was supported between them. The surgeon passed the index and middle fingers of his left hand into the rectum, with a view to press against the stone and force it forwards into the neck of the bladder, making it thereby prominent in the perinæum. This being done, he made a lunated incision about midway between the margin of the anus and the bulb of the urethra, the concavity of the curve looking down to the former, its extremities being directed towards the ischia—"cornibus ad ischia spectantibus." In this way he cut down upon the stone, and sought to push it through the wound; but if that did not succeed he used a hook to assist in its extraction. This mode of operation was subsequently called "cutting on the gripe;" and from the fewness of the instruments required for its performance, it was described as the *apparatus minor*, to distinguish it from another in which several were employed. The parts divided in the incisions were —the skin and superficial fascia, part of the fibres of the accelerator muscles, and the transverse muscles; finally, the prostatic part of the urethra, the lower half of which was thrown down in the form of a flap. It is not at all unlikely that the urethra was in many cases cut across and severed altogether from the bladder. Heister says, that the stone was made prominent at the left side of the perinæum, and that an oblique incision was then made down upon it. The line of incision marked in his plate corresponds exactly with that of the lateral operation, as now performed; so that he must have taken his delineation from the mode of operation practised in his own time, and not from that described by Celsus.

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* *Lib. 7. cap. 26.*

After the revival of letters, when every dictum of Hippocrates passed for doctrine, a method of operation was devised by one Johannes Romanus, founded on a dogma of the father of physic, "that wounds of membranous parts do not unite." Its description was subsequently given by one of his disciples, named Marianus Sanctus, from which circumstance it was afterwards called "sectio Mariana," but is better known as the *apparatus major*, from the variety of instruments it required. When the perinæum was exposed, a grooved staff was introduced, and an incision made with a razor along the middle line, extending from beyond the bulb to within a finger's breadth of the margin of the anus. A second incision laid open the bulbous part of the canal, which concluded the cutting part, as all the rest was to be done by dilatation; for though the rules of art forbade the division of membranous parts, they laid no injunction against their being stretched. Hence the operation was of a mixed character, founded partly on the necessity of resorting to incisions, and partly on the equally imperative necessity of deferring to authority. When the urethra was laid open, dilators were introduced, in order to distend the canal sufficiently to admit the forceps; but, as may be concluded from a consideration of its structure and width, laceration was the immediate result, and not simple dilatation. The after consequences may be readily inferred.

At a subsequent period, a method of operation was projected and carried into execution by a monk, named Frère Jacques, who appears to have been altogether unacquainted with anatomy, and even otherwise illiterate, and yet his plan must be admitted to have paved the way for the introduction of that which is now most generally employed. Having introduced a common catheter (not grooved) he therewith caused the bladder to be made prominent in the left side of the perinæum: he, in the next place, inserted a long bistoury between the anus and tuber ischii, but nearer the latter; and, directing it upwards and forwards, he entered the bladder at its side, and cut through the neck, "without injuring* any other part of the urethra." When the operation was performed on the dead subject, it was found, that "the integument having been divided for about two fingers breadth, the wound next passed between the accelerator and erector muscles, without injuring either, and had penetrated the neck of the bladder, and part of its body, for about an inch†." This was subsequently termed the *lateral operation*, both because the incision was parallel with the side of the perinæal space, and also because it opened its way into the side of the bladder. This plan was acted on, but modified and improved, by Ravius, or Raw, in Holland, and Cheselden, in this country, both of whom used a grooved staff. Mr. Cheselden, in his first operations, entered the bladder at the side, and then divided the neck by drawing the scalpel from within outwards, or towards the surface. It must be very difficult to extract, without laceration, a stone of any size through an incision placed so deeply, and corresponding with the side, and not with the most depending point of the bladder: for this reason, as well as from its having been followed by sloughing of the cellular substance round the rectum, caused by infiltrations of urine, this method was soon abandoned. An objection of another sort may also be taken to it, derived from a consideration of the direction in which the incision in the bladder is made. The point of the scalpel is entered at a part comparatively unsupported and moveable, and is thence directed towards the neck, which, by means of its attachments, is held fixed, which is contrary to an obvious principle in the making of incisions. This Cheselden effectually remedied, by entering his scalpel into the groove of the staff, where it lies in the membranous part of the urethra, and passing it from before backwards, so as to divide the prostate gland and neck of the bladder. The operation, as devised by this eminent surgeon, and practised at the present day, may be performed as follows, (attention is here confined to the operative part exclusively, all other details and preliminaries being foreign

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* Heister, System of Surgery. † Ibid.

in many cases . grooved staff, corresponding in size
Heister says. in the first place introduced, and so
of the perin ies close beneath the pubic arch, whilst
upon it. somewhat towards the left side of the
exactly of the scalpel is then laid on the skin, close
that he raphé, at about fourteen lines before the
tion and is thence drawn downwards and outwards
Cel etween the margin of the anus and the left tuber
a little nearer to the latter: this divides the skin
fascia. The second incision, commencing a quar-
ch, or a little more, according to the size of the bulb,
upper end of the first, is carried downwards in the
ection and extent, and so divides the lower fibres of the
ator muscle, the transversalis perinæi muscle and artery,
part of the levator ani and deep perinæal fascia. The staff
uld now be sought for at the upper angle of the incision:
the bulb be large, it will be necessary to press it aside with the
dex finger of the left hand. The point of the scalpel being elevated, by depressing its handle, and throwing the hand a little back, it is made to enter the groove of the staff, its lodgement therein being ensured by moving it slightly from side to side, and then is passed along the groove, so as to lay open the membranous part of the urethra. When this has been effected, the operator draws downwards to himself the handle of the staff (its concavity being held securely beneath the pubic arch), by which means its beak is made to move upwards and backwards, and so removed from the rectum. Whilst this is being done, the scalpel (previously lateralized, so that the direction of its edge shall correspond with that of the external incision) is made to slide along the groove, dividing in its passage the prostatic part of the urethra and of the neck of the bladder. After this has been completed, the scalpel is withdrawn a little, and carried obliquely downwards in the direction of the first incision, so as to divide any septa that may lie across the wound, which usually consist of part of the fibres of the levator ani, and of the transversus perinæi, if not severed in the second incision. The advantage, or rather the necessity, of freely dividing the membranous part of the urethra, previously to depressing the staff, has been put in a very clear point of view by

Mr. Colles*:—" If you have entered your knife into the urethra, high up in the perinæum, and, while the point of the knife is lodged there, should depress the staff, and attempt the division of the prostate, you will have to make it describe a portion of a circle at the same time that it is dividing very resisting parts."

This brief historical notice shews us at one view the various routes that have been chosen at different times to reach the bladder, through the perinæum: narrow as the space is, it is surrounded with parts on every side that must be avoided. The rectum lies beneath the line of incision, the pudic artery outside it, and the artery of the bulb above it; and, again, whilst passing into the bladder, the incision must be so made as to avoid the ejaculatory ducts. Notwithstanding these difficulties, if the parts were unvarying in their relations, the execution of the operation may be made comparatively easy, by performing it a number of times on the dead subject. But, in addition to the complexity of the lines of incision, and their close contiguity to parts which should not by any means be wounded, there is another source of difficulty which is seldom attended to, and which arises from the fact, that the depth, as well as the dimensions of the perinæal space, vary, in different individuals, far more than could at first sight be supposed. It is usually said, that the space is included within three lines, each three inches long, so that it is an equilateral triangle; and, as the operation is now performed, the left lateral half of that triangle is alone interested. The extent of the space here indicated is more than the average. Professor Dupuytren measured the distance between the tuberosities of the ischia in twenty-three subjects, taken indiscriminately from the dissecting rooms, and found that in some, it was not more than two inches, but in others, was as much as three and a half. Again, by placing one branch of a pelvimetre at the surface of the perinæum, and the other at the neck of the bladder, it was ascertained that the distance between them, or, in other words, the depth of the perinæum, was in some instances only an inch and some lines, in others four inches and a quarter.

A method of proceeding has lately been devised †, with a view to remove altogether the necessity of incisions for the extraction of calculi. Chemical solvents were some time since proposed with the same laudable intention, but they were tried and found ineffectual. Mechanical trituration forms the basis of the new method, its object being to reduce the calculus to powder, or to fragments sufficiently small to admit of their being drifted out of the bladder by the stream of the urine. The instrument used for this purpose is a straight tube, resembling a large-sized catheter, and so contrived as to carry within it a rod, the extremity of which is so constructed that it will bore through the calculus when made to act upon it. The corresponding extremity of the tube is also arranged so that, on reaching the bladder, it can be made to divide into prongs, within which the stone is seized, and secured whilst its trituration is being effected. When the instrument is introduced into the bladder, and the stone found and seized (which is not so easily done as may be imagined), the end of the rod is made to act on it on the principle of a drill, so as to bore it through. In the instrument first employed, the rod was turned by a handle attached to its external end, resembling somewhat that of a small windlass. This must have caused a considerable degree of lateral motion during the operation, and no little pain and irritation in the urethra and neck of the bladder; and accordingly we find, that an attempt was made to diminish it, for the operator hit on the plan of attaching a small wheel to the end of the rod, and working it with a bow-string, such as mechanics use when drilling holes. This, no doubt, lessens the motion, but does not prevent it altogether, as must be evident to any one who considers the circumstances in which the instrument is placed. One end of it, with the stone therein grasped, is loose and unsupported in the bladder; and let the bow be used ever so adroitly, the tube must jar against the urethra and neck of the bladder, causing thereby pain and irritation. When the stone is perforated, it must be let go, with a view to its being caught up in another position, and bored in a different direction, and so the process must be repeated until it is sufficiently perforated to admit of its being crushed by means of the prongs of the tube, which are pressed by the action of a screw upon it. The process then must be slow and painful, so that it can seldom, if ever, be done on one occasion, and therefore becomes the business of two or even three operations. After the stone has been crushed, should any of the fragments happen to be too large to pass through the urethra, the operation must be repeated, which renders it difficult, if not impossible, to say when it is completed. Now, suppose every thing to be done in the way of trituration and bruising that an instrument can do, we may just raise this question,—What are the immediate effects of the operation, and what are its remote consequences? The urethra and neck of the bladder, both sensitive in no small degree, having suffered during the operation a degree of irritation proportioned to the susceptibility of the individual, and of the part, from its previous condition, begin now to be subjected to the additional irritation consequent on the passage, from day to day, for an indefinite period, of a quantity of sabulous and gritty matter over their surface. After all this, should a fragment of any size remain (an occurrence far from unlikely,) the local and constitutional irritation may be such, that the triturating process cannot, or will not, again be submitted to, and then the operation by incision must be resorted to, under most unfavourable circumstances. If the calculus be large, or of the mulberry species, it would require a considerable force to crush it, even though it be perforated in several directions; and if, in the endeavour to accomplish this, one of the prongs were to give way, (an accident not unlikely to happen to those not habituated to the use of such instruments,) the operation by incision cannot be deferred, even though it becomes necessary to lay open a bladder irritated by the previous proceedings. To conclude, this expedient cannot, under any view of it, be considered as a substitute in all cases, nor even in the majority of cases, for the operation by incision. It cannot be resorted to in persons of an irritable habit, or in cases in which the bladder has become contracted and irritable by the long continuance of a calculus within it; neither is it practicable in children, for in them the urethra will not admit, without great suffering, a straight instrument, nor will it carry one of sufficient size to admit of its prongs being stout enough to exert any considerable force on the stone. It is applicable, then, only in cases that may be considered free from local or constitutional irritation, and even in such it may induce both, without ensuring a complete removal of the stone.

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* *Treatise on Surgical Anatomy*, p. 211.

† *Lithontritie*, par Civiale.

CHAPTER IX.

THE THORAX.

617. The thorax is somewhat conical in its form, and intended to lodge the central organs of circulation and respiration. It is intermediate not only in size and situation, but also in the structure of its walls, between the abdomen and the cranium, the one being composed almost entirely of soft parts, and the other an osseous case, whilst the thorax consists of muscular and osseous parts in nearly equal proportions. The intercostal spaces are filled on each side by two orders of muscular fibres, disposed, in lamellæ, one within the other.

618. 1. The *external intercostal muscles* are placed between the contiguous borders of each pair of ribs. There are, therefore, eleven such muscular lamellæ on each side, the direction of the fibres of all being obliquely downwards and forwards. Their extent in each instance is from the tubercles of the ribs to the external extremity of their cartilages. 2. The *internal intercostal muscles*, commencing at the sternum, in the spaces between the true ribs, and in the rest, from the anterior extremities of their cartilages, extend as far as their angles, the direction of their fibres being obliquely downwards and backwards.

619. The *levatores costarum* are narrow, tendinous, and fleshy fasciculi, which extend obliquely downwards and forwards (in this particular resembling the external intercostals) from the extremities of the transverse processes of the dorsal vertebræ, to be inserted into the margins of the ribs, between their angles and tubercles.

Actions.—The two planes of intercostals act simultaneously; and as they decussate with one another, the ribs on which they act are made to move in the direction of the diagonal of the moving powers, that is to say, directly upwards, when the first rib is relatively the more fixed point; and downwards, when the last happens to be so. In drawing up the ribs, they slightly rotate their bodies, and evert their lower borders; they at the same time widen the intercostal spaces, and spread the ribs from one another somewhat like those of a fan. This they are enabled to do by the peculiar mode of attachment of the last rib, which is prevented from ascending with the rest by the manner in which the quadratus lumborum binds it to the ileum, so that it serves to spread or separate them from one another.

620. The *diaphragm* is a thin septum placed between the thorax and abdomen. It presents two lateral parts, united along the middle line, but the parts are not symmetrical, on which account it cannot be classed with the muscles of animal life, nor yet with those of organic: in structure, it forms a link intermediate between these two orders, and in function partakes of the properties of both, being involuntary in its ordinary actions, yet not altogether withdrawn from the control of the will. The diaphragm, viewed as a whole, consists of three portions, two of which are muscular—the third, which forms the connexion between them, being tendinous. The muscular fibres of each lateral part arise from the inner surface of the cartilages of the ribs, from the seventh to the twelfth inclusive; and in the interval between the cartilage of the twelfth rib, and the transverse process of the first lumbar vertebra, they arise from a fibrous band stretched between these points. This, by its lower border, is continuous with the anterior lamella of the fascia lumborum (p. 197), and is sometimes termed *ligamentum arcuatum.* But Haller[*] very properly distinguishes this from another

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[*] *Icones Anatomicæ.*

tendinous lamella, which arches obliquely over the psoas muscle, being attached by one extremity to the transverse process of the first lumbar vertebra (where it is blended with the preceding), and by the other to the body of the second. This he terms "arcus interior:" it may be named, *ligamentum arcuatum proprius.* The fleshy fibres from these different points of attachment proceed to their destination in different directions; those in front pass backwards, those at the sides directly inwards, the intermediate ones being oblique; but the fibres from the exterior tendinous arch pass directly upwards, all becoming inserted into, or continuous with, the fibres of the central aponeurosis.

621. The *central aponeurosis* (*centrum nerveum*) is composed of tendinous fibres interwoven in every direction. Its narrow extremity or foot-stalk is turned towards the spine, the wider (which is divided into three processes) towards the margin of the thorax; hence it was compared by Winslow to a trefoil leaf. The central leafet is the largest, the left the smallest, the right being intermediate in size between them. Between the right and middle divisions, a little anterior to the spine, is an opening (*foramen quadratum venæ cavæ*) for the vena cava; it is somewhat of a square shape, and resembles rather a canal than a foramen.

622. The *lumbar portion* of the muscle consists of two thick fleshy processes, *crura* or *pillars,* placed at each side of the middle line. The right crus, broader and longer than the left, is attached to the forepart of the bodies of the vertebræ, whilst the latter inclines rather to their sides. The right crus arises by fleshy fibres from the three upper lumbar vertebræ, and by a firm tendinous process from the intervertebral substance, between the third and fourth. The left does not extend so far down, by the breadth of half a vertebra. As they ascend they leave an interval between them which lodges the aorta, and opposite the

first lumbar vertebra, the fibres of each crus proceed to three different destinations. The greater number pass forwards and upwards to be inserted into the central aponeurosis; those placed towards the sides of the vertebra incline outwards, and terminate upon the surface of the ligamentum arcuatum proprius; but the internal fasciculus of each passes in front of the aorta, so as to complete the canal, (*hiatus aorticus*) which transmits it. The fasciculi decussate at this point; the one from the right side is the larger, but is concealed by that from the left, which lies in front of it. After their decussation the fasciculi are continued obliquely upwards, forming the margins of the opening for the œsophagus (*foramen œsophageum*), and are ultimately inserted into the central aponeurosis. The œsophagean opening is narrow and elliptical in its form, its greatest diameter being from before backwards, and about an inch and a half or two inches in length. It lies a little to the left of, and anterior to, the aortic opening, and transmits the œsophagus with both the vagus nerves. The aortic opening corresponds with the middle line, and gives passage to the aorta, thoracic duct, and also, in most instances, to the vena azygos. The opening for the vena cava lies before and to the right of that for the aorta.

Actions.—The diaphragm is of an arched form, the concavity of the arch looking down into the abdomen. When its fibres contract, the muscle descends, and becomes an inclined plane, whose direction is downwards and forwards. By these means the abdominal viscera are pressed against the lower and forepart of the parietes of the cavity, so that the capacity of the abdomen is diminished in proportion as the thorax is enlarged. Should the abdominal muscles and the diaphragm be both brought into action together, the viscera will be compressed between them, and forced towards the lower part of the cavity, as occurs in the expulsive efforts of accouchement, &c.

The Lungs.

623. The lungs constitute the organ of respiration, and are two in number; they occupy the lateral parts of the cavity of the thorax, which they completely fill. Each lung is of a conical figure, and rests upon the diaphragm, whilst its summit extends a little above the first rib. The external surface of the lung, smooth and convex in its general outline, corresponds with the arch of the ribs; the internal is compressed, and rests against the mediastinum, and at its middle third, the bronchi and vessels enter its substance, forming, by their aggregate, what is called the root of the lung. The anterior border is thin and sharp, whilst the posterior is rounded and prominent, being received into the groove formed between the vertebral column and the ribs. The base, surrounded by a sharp border, is concave, and rests on the arch of the diaphragm, whilst the summit forms a slightly elongated prominence, where it ascends between the scaleni muscles. Each lung is divided into lobes, by a deep fissure, whose direction is from above downwards, and from behind forwards; the lower lobe of each is thus quadrilateral in its figure, the upper conical. The perpendicular depth of the left lung is greater than that of the right, as the corresponding part of the diaphragm does not ascend so high; its inner border is also excavated to receive the pericardium and heart. The right presents three lobes; the third being intermediate in size and situation between the two others. It appears like an angular piece, detached by a groove from the anterior and inferior part of the upper lobe.

624. Each lung is invested by a serous lamella, derived from the pleura; its interior is lined by a prolongation of mucous membrane, and the intervening structures form, by their aggregate, what is called the parenchyma of the organ.

625. The *Pleuræ* are two thin, semi-transparent membranes placed in the thorax, and so disposed as to form each a shut sack, thus conforming to the general law of serous membranes. Each membrane will be thus found to line the inner surface of the thoracic parietes, and to be reflected over the corresponding lung, giving it a smooth investment, the point of reflection corresponding with the root of the organ. Inferiorly, the membrane covers the convex surface of the diaphragm, and superiorly, forms a small cul-de-sac at the bottom of the neck, over the summit of the lung. The part of the membrane which invests the lung is called *pleura pulmonalis*, that which lines the thorax, *pleura costalis*. These two membranous sacks, by their apposition along the middle line, form a septum (*mediastinum*), which divides the thorax into its two lateral chambers; it extends from the top of the thorax to the diaphragm, and from the spine to the sternum, with some inclination to the left side (inferiorly), owing to the position of the pericardium and heart. The interval between the two membranes in this situation gives lodgement, immediately behind the sternum, to the thymus gland, and some cellular tissue; and lower down, to the pericardium and heart. Along the spine, we find similarly situated, with regard to the membranes, the œsophagus, the vagus nerves, the descending aorta, thoracic duct, and splanchnic nerves, with some lymphatic glands and cellular tissue. Now the bronchi and root of the lungs, by their transverse position, separate the mediastinal interstice into two parts, of which one is termed, ordinarily, the *anterior*, and the other the *posterior mediastinum*.

Structure.—The anatomical constituents of each lung are:— 1. The bronchus and its ramifications. 2. The pulmonary artery and pulmonary veins. 3. Bronchial arteries and veins. 4. Lymphatics. 5. Nerves of the pulmonary plexus. These are in closed in a quantity of cellular tissue, which forms a connecting medium between them.

1. The *bronchus* is a division of the trachea; the latter is a cylindrical tube extending from the cricoïd cartilage to the second or third dorsal vertebra, where its division into the bronchi takes place. It rests on the œsophagus, which, however, inclines somewhat to its left side. It is inclosed between the great vessels of the neck, and covered partly by the thyroid gland and its veins, also by the sterno-hyoid and sterno-thyroid muscles, and crossed by the left vena innominata, the arteria innominata, and the arch of the aorta. The bronchi, commencing at the bifurcation of the trachea, incline laterally towards the lungs; the right one, larger but shorter than the other, inclines outwards, almost horizontally, and enters the lung on a level with the fourth dorsal vertebra; it is inclosed by the termination of the vena azygos, which hooks round it, and by the arch formed by the right pulmonary artery. The left bronchus, less in diameter, but longer than the right, inclines obliquely downwards and outwards to reach the lung. The arch of the aorta hooks round it, and the left pulmonary artery lies upon its superior and anterior border. Each bronchus, at its entrance into the lung, divides into two branches, one being intended for each lobe. The lower branch of the right lobe also subdivides, or rather gives off a branch to its middle lobe. Each bronchial ramification again resolves itself into two tubes of smaller size; and so, by means of this binary division, continued through five or six successive stages of decrease, a series of tubes is formed, increasing in number as they decrease in size, until, finally, each becoming capillary, terminates in a minute cul-de-sac or air-vesicle, the aggregate of which constitutes the proper cellular structure of the lungs. The trachea is composed of fibro-cartilaginous rings, varying from sixteen to twenty in number, and of membranes which connect them. A thin, yet elastic fibrous lamella, forms the circumference of the tube, serving to connect the cartilaginous rings, which seem as if developed in its interior, and also to complete the circuit posteriorly where these rings are deficient. Interior to these is situated the mucous lining, continuous superiorly with that of the larynx, and ulti-

mately prolonged through the bronchial ramifications. Where the cartilaginous rings are deficient, the mucous membrane is supported by some longitudinal fibres, and beneath it we also find a series of muscular fibres resembling those of the intestinal canal. These are disposed transversely, so as to connect the extremities of the cartilaginous rings. The bronchi and their primary ramifications are made up of the same constituents as the trachea, but the rings are found gradually to lose their annular form, and to degenerate into lamellæ of irregular shape, placed in different parts of the circumference of the canal. At the several points of subdivision, however, they are still somewhat annular, so as to keep their orifices open. The rings thus gradually disappear, so that at the ultimate divisions of the bronchi they no longer exist, nor are they required, for the air which distends the vesicles is never altogether excluded from them. So far as the bronchi are cognizable by our senses, they appear to consist of materials analogous to those found in the larger tubes, but gradually reduced to the greatest degree of tenuity. If they be injected with quicksilver, the globular form of the vesicles, and the cylindrical form of the ultimate ramusculi which terminate in them, are rendered manifest; and as the mucous membrane is prolonged into the vesicles forming their lining, it is a legitimate matter of inference, from the various facts disclosed by the general anatomy of tissues, that the fibrous lamellæ and muscular structure extend to them also. In support of this inference it may be urged, that if the lungs were simply passive, and therefore incapable of contributing to the expulsion of the air, the subsidence of the thorax upon them would only press the air out of the parts near their surface, but could exert little influence over those which are deeper seated. Besides, if one side of the thorax of a living animal be opened, the degree in which the lung becomes diminished is greater than that which is ordinarily produced by the weight of the atmosphere. This indicates a contractile, and even an irritable power in the organ.

2. The *pulmonary artery* arises from the base of the right ventricle of the heart, from which it proceeds upwards and towards the left side for the space of about two inches, where it bifurcates into its right and left branches. It partially conceals the aorta at

its origin, and is connected with it by the serous lamella of the pericardium. At its point of bifurcation it is also connected to the concavity of the aortic arch, by the ductus arteriosus in fœtal life, and subsequently by the ligamentous remains of that vessel. The right branch, larger and longer than the left, inclines almost transversely towards the corresponding lung, which it reaches after passing behind the ascending aorta and the superior vena cava: it lies upon the right bronchus, but soon makes a turn so as to embrace it; after which it divides into three branches. The left branch passes in front of the descending aorta, immediately beneath its arch, and after reaching the upper border of the corresponding bronchus, divides into two branches. The primary and each succeeding division of the pulmonary arteries correspond with those of the bronchial tubes, whose course they follow to their final terminations in the air vesicles, where they become capillary.

The *pulmonary veins,* two in number on each side, commence by minute radicles, which are continuous with the capillary terminations of the arteries. They are found to converge to the root of the lung, from different parts of its structure, and in their course increase in size as they diminish in number. The veins of the right lung pass behind the right auricle and the superior vena cava; those of the left have a shorter course to run, in order to reach the left auricle, which is their common destination.

3. The *bronchial arteries* are remarkably variable in their number and mode of origin. That of the right side comes either from the aorta, or the first intercostal artery; the left arises singly, or by a trunk common with the preceding vessel, from the aorta. On reaching the root of the lungs, each divides into four or five branches, which follow the divisions of the bronchi until they become capillary. The veins which return the blood of the bronchial arteries, do not unite to form trunks corresponding with those of the latter: some of them terminate in the vena azygos, or the superior cava: similar vessels pass from the posterior part of the lung into the œsophagean and intercostal veins. In other situations some of them open into the pulmonary veins. Some anatomists have been led to conclude, from a consideration of the size of the lungs, that they could not be dependent on the bronchial arteries

alone for their nutrition. A similar idea seems to have been entertained concerning the nerves, by Haller, who says, "Neque multos, nec magnos pulmonis nervos esse." But if we compare not the size, but the quantity of matter of the lungs, with that of any other organ, even with the liver, we shall find no reason to question the sufficiency of the bronchial arteries, or to doubt whether they are as well supplied with nerves as other parts.

4. The *nerves* of the lung are derived from the two pulmonary plexûs placed one in front of the bronchi, the other behind them; the latter being the larger. The nervus vagus contributes much the greater share to the formation of the plexûs, assisted by the intercostal nerve. The branches of both form an inextricable interlacement exterior to the lungs, but are not found to anastomose within their substance. An opinion for some time prevailed, that the gangliac nerves were distributed exclusively to the vessels of the lung, and those of the nervus vagus to the bronchi. But Reiseissen*, after a most minute examination of this, and almost every other question that can be raised concerning the structure of the lungs, has come to the conclusion, that the branches derived from the nerves belong alike to the vessels as to the bronchi, and ramify indiscriminately on both.

5. The *lymphatics* of the lungs are divisible into two sets; one being superficial, the other deep seated. The superficial vessels run beneath the pleuræ, and after ramifying, so as to enclose, areolar spaces, terminate in the bronchial glands at the root of the lung. The deep set take the course of the veins; they enter the bronchial glands, and after having emerged from them again, they pass along the trachea; those of the left side terminating in the thoracic duct, those of the right in the lymphatic trunk of the corresponding side.

Pericardium.

626. The pericardium is a membranous sack which invests the heart, and the commencement of the large arterial and venous trunks which are connected with it. It is composed of two layers, the external being fibrous, the internal serous: it is situated above the central aponeurosis of the diaphragm, behind the sternum and cartilages of the third, fourth, and fifth ribs of the left side, before the bronchi, œsophagus, and descending aorta, and between the reflected layers of the pleuræ which separate it from the lungs. Though the two membranes of which the pericardium is composed are intimately united, still their general distribution, as well as their structure and properties, are so different, that it is impossible to describe them together: we must, then, notice each separately.

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* *De structura pulmonum.*

627. *The fibrous* membrane, dense, thick, and unyielding, consists of fibres which interlace in every direction. Most of them are attached to the central aponeurosis of the diaphragm, and superiorly, where they embrace the large vessels, they form tubular prolongations, which after passing for some way upon them, become blended with their external coats. The internal or *serous* lamella represents a shut sack partially inverted on itself, and so disposed as that the internal or inverted part embraces the heart, whilst the other lines the inner surface of the fibrous lamella. It was the great simplicity of arrangement observable in the serous pericardium, as contrasted with that of other membranes of the same class, that suggested to Bichât the idea of comparing it to a double night-cap: for if the heart could be drawn out of it without injury to its continuity, it would resemble an elongated sack closed on all sides, and we should then have demonstrative proof, that though that organ is invested by the membrane, it is still without its proper cavity.

The Heart.

628. The *heart*—the central organ of the circulation—is a hollow muscle, irregularly pyramidal in its shape, which lies between the lungs, enclosed in its proper investment—the pericardium. It is placed so obliquely, that if a line corresponding with its axis were passed through it, at the

moment of its pulsation, its direction would be downwards, forwards, and to the left side. The anterior surface of the heart is convex in its general outline; the posterior is flat, and rests on the diaphragm: the lower, or right border, is rather thin, and longer than the upper, which is rounded. The heart's surface is marked on its upper and under aspect by two lines, of which one runs transversely, the other from above downwards; their position indicates the division of the organ into four different compartments, or cavities. The base of the heart (which is comparatively thin and flaccid in its structure) consists of that part which is in immediate connexion with the veins (*pars cordis venosa*), and is divided into two cavities, called auricles, from the fact that each is surmounted by an appendage resembling an ear (*auricula*). It is separated from the lower, or pyramidal part, by a deep transverse groove (*sulcus auriculo-ventricularis*). These facts can be distinctly recognised only when the heart is distended. The portion between the transverse sulcus and the summit is thick and muscular, and connected with the arterial trunks; it consists of two cavities (ventricles), the division between which is indicated by two slight grooves extending from base to apex, and lodging the descending branches of the coronary vessels.

629. The *right auricle* (*sinus venarum cavarum*) rests on the diaphragm, and forms the right and anterior part of the base of the heart. Its external surface, unattached in the greater part of its extent, is prolonged upwards, and to the left side, into its auricular appendage; inferiorly it is connected with the right ventricle, internally with the left auricle, and into its two extremities open the venæ cavæ. In order to examine its interior, an incision may be made from the junction of the cavæ across to the auricula, from the middle of which another may be carried upwards into the superior cava. If the lower border of this incision be drawn forwards, the cavæ will be observed

to meet at an angle, their junction being marked by a slight elevation, called *tuberculum Lowcri.* The greater part of the cavity forms a pouch (*sinus auriculæ*), which is smooth, and but slightly muscular in its structure. The inner surface of the auricula is distinguished from the rest by several fleshy fasciculi, which run transversely upon it, called *musculi pectinati.* Just above the orifice of the inferior cava is situated an oval depression (*fossa ovalis, vestigium foraminis ovalis*), indicating the original communication between the auricles: its upper border is formed by a fleshy ring (*annulus ovalis*). At the line of union between the inferior cava and the auricle is situated a crescentic fold of the lining membrane, called *valvula Eustachii.* Between this valve and the ventricular opening is situated the orifice of the coronary vein, protected by a valve. Several minute foramina may also be observed in different parts of the auricle, resembling the orifices of small veins, and called *foramina Thebesii.* Placed obliquely between the appendix and the inferior cava, we observe the auriculo-ventricular opening of an elliptic form, and about an inch in diameter; round its circumference is attached the tricuspid valve, the rest of which lies in the cavity of the ventricle.

630. The *right ventricle* (*ventriculus pulmonalis*) extends from the base of the right auricle to the apex of the heart. Its form is somewhat triangular: to see its interior, it will be found convenient to make an angular or V-shaped flap, by dissecting up its anterior wall. When this is done, we observe that the interior surface presents a number of fleshy pillars, which, by reason of their modes of attachment, are divisible into three orders. The first, adherent by both extremities, are free in the rest of their extent; others are but slightly prominent, being attached by their extremities, as well as by the greater part of their circumference: the third set form three or four fasciculi, which are directed from the summit towards the base of

the ventricle, where they are connected with the apices of the tricuspid valves, through the medium of several tendinous processes, called *chordæ tendineæ*. The base of the ventricle is prolonged upwards, somewhat in the form of a funnel, where it gives attachment to the pulmonary artery. At the point of junction, three membranous folds are placed, called *sigmoïd valves*. One border of these is attached at the line of union of the ventricle with the artery, the other is free in the cavity of the latter, and presents in its middle a small granule, called *nodulus* or *corpus aurantii*. The *tricuspid valve* is so called from its being divided into three points: it is formed by processes of the lining membrane of the auricle and ventricle: along its margin are inserted the chordæ tendineæ.

631. The *left auricle* (*sinus pulmonalis*) is situated at the posterior part of the base of the heart, where the greater part of it is concealed by the pulmonary artery and the aorta, which overlap it, the auricular appendage alone being visible, without detaching these vessels, or inverting the position of the heart. When distended, it is of a square form, and into its angles open the pulmonary veins, those of the left lung being very close together. From its upper and left extremity projects the auricula, which is smaller, and less muscular than that of the right side. A slight depression may be observed in the septum auricularum, corresponding with the fossa ovalis; the rest of the surface being smooth and even. In the inferior part of the cavity is situated the auriculo-ventricular opening, the circumference of which gives attachment to the mitral valve.

632. The *left ventricle* (*ventriculus aorticus*) occupies the left border of the heart, about one-third of its extent appearing on the anterior surface, the rest being placed posteriorly, owing to the obliquity of the septum ventriculorum. Its cavity can be conveniently exposed by making two incisions through its wall, parallel with the septum,

and uniting at an angle near the apex. When the flap thus formed is drawn upwards, the great thickness of the walls of the cavity, as compared with those of the right ventricle, is rendered manifest. The columnæ carneæ resemble those of the right side, but are thicker, and directed, for the most part, from the base to the apex of the heart. Two fleshy fasciculi, of considerable size, pass towards the apices of the mitral valve, to which they are connected by chordæ tendineæ, similar to those in the right ventricle. The auriculo-ventricular opening is guarded by a valve, similar in structure to that of the right side, but differing from it in presenting but two pointed processes; hence it has been termed the *mitral valve* (*valvula mitralis*). The larger division of it looks towards the aortic opening. To the right side of, and before the large opening just noticed, is situated a smaller one, which communicates with the aorta, and is guarded by three valvular folds of the lining membrane, similar in structure and form to those of the pulmonary artery, and also called *sigmoïd*, or *semi-lunar valves*.

From the right ventricle arises the pulmonary artery, from the left the aorta. The mode of connexion of these vessels to the heart deserves to be particularly noted. The middle coat of the arteries is not a prolongation of, nor is it continuous with, the substance of the ventricles. It presents, in each case, a festooned border, marked with three points, separated by three arched intervals. The points are applied to the margin of the ventricle, and connected to a thin ligamentous ring, which surrounds it, by means of some fibrous tissue, the intermediate spaces being also filled up by a similar structure. The internal coat of each artery is continuous with that which lines the corresponding ventricle, and the serous layer of the pericardium, by being reflected from the artery to the heart, strengthens the connexion between them. At the origin of each vessel, the lining membrane is doubled into three semi-lunar folds (*valvulæ semi-lunares*). The convex border of these is attached to the line of union of the artery with the ventricle: the straight one, slightly thickened along its margin, presents in the middle a small granule *(nodulus)*. When collapsed, each valve rests on the surface of the artery; but when the vessel is distended, the valves resemble so many small pouches, their convex surface being directed down towards the ventricle, the concave towards the artery, and the straight border of each so closely in contact with the others, that an effectual barrier is presented against regurgitation into the ventricle.

633. The *aorta.*—The primary arterial trunk of the body is called the *aorta:* it continues undivided from its origin at the left ventricle of the heart to the fourth lumbar vertebra, where it divides into the iliac arteries. Immediately after its origin, it proceeds upwards, forwards, and to the right side, until it reaches the level of the cartilage of the second rib, where it inclines backwards to the spine, to gain the left side of the body of the second dorsal vertebra. At the point just indicated, the vessel changes again, inclining downwards and inwards on the side of the third vertebra, thus completing three parts of a circle. This is named the arch of the aorta. The ascending part of it is at first overlapped by the pulmonary artery, and afterwards lies between that vessel and the superior vena cava; it lies behind the sternum (the pericardium and some cellular tissue interposing), and is supported by the right pulmonary artery and veins. The transverse part of the arch is horizontal in its direction, and rests on the extremity of the trachea. From its upper or convex border arise the three great arteries which supply the head and upper extremities; its concavity is connected with the pulmonary artery by the ductus arteriosus, or the tendinous cord into which it degenerates, and round it coils the recurrent branch of the vagus nerve. The third, or descending part of the arch, lies behind the root of the left lung. The branches that arise from the aortic arch are the following:

The *coronary arteries*, two in number, are so called from the manner in which they encircle the heart. They are lodged in the sulcus between the auricles and ventricles, and send branches for their supply. Both arise immediately above the margins of the sigmoïd valves. The *right* coronary artery inclines outwards between the right auricle and ventricle, and continues round in the sulcus, anastomosing with the left. Its most remarkable branches are two, which descend to the apex of the heart, where they anastomose with similar branches from the other coronary artery. The *left* coronary artery is similarly situated between the left cavities of the heart. Its largest descending branch, as it runs towards the apex, indicates the position of the septum ventriculorum.

The *arteria innominata* is a short but thick vessel, which extends from the highest point of the arch to the sterno-clavicular articulation of the right side, where it divides into the subclavian and carotid arteries. (Sect. 518.) Its direction is obliquely upwards and outwards; it rests on the trachea, is crossed by the left vena innominata, and separated from the first bone of the sternum by the origins of the sterno-hyoid, and sterno-thyroïd muscles.

The *left carotid artery* arises close by the innominata, from which, as it ascends, it becomes separated by the breadth of the trachea. Its course has been given (Sect. 518.)

The *left subclavian artery* arises from the transverse part of the arch, at its most depending point; it thence ascends, overlapped by the left lung and the pleura, to reach the first rib (Sect. 534.)

634. The aorta, as has been stated, having completed its arch at the left side of the third dorsal vertebra, descends towards the diaphragm, assuming the name of *descending* or *thoracic aorta*. It gradually inclines from the left side of the spine towards its forepart. Its left side is in close contact with the reflected lamella of the pleura, forming the mediastinum; on the right lie the vena azygos and the thoracic duct; whilst the œsophagus, similarly placed for some way, crosses it near the diaphragm, to

reach the aperture which transmits it to the abdomen. Its branches are :—

a. Pericardiacæ are some small ramusculi, which ramify on the pericardium.

b. Rami bronchiales arise singly, or by a common trunk, from the aorta; one of them sometimes arises from the first intercostal artery. However variable they may be in their origin, their course and distribution are sufficiently constant. They pass forwards to the root of the lungs, and accompany the bronchi, and their different ramifications. They seem to be the proper nutritious vessels of the lungs.

c. Rami œsophageæ are several in number; they freely supply the œsophagus, and some of them, by descending upon it, anastomose with the branches of the coronary artery of the stomach.

d. Rami intercostales vary from eight to ten in number; they arise from the posterior part of the aorta, from which they incline outwards and upwards on the bodies of the vertebræ. They are covered by the pleura, and crossed by the sympathetic nerve. At the heads of the ribs, they send branches backwards to the dorsal muscles, and also through the inter-vertebral foramina to the spinal canal. The continuation of each artery then passes forwards between the two layers of intercostal muscles, lodged in the groove at the lower border of the corresponding rib, and somewhat beyond the middle of the rib divides into two branches, which run nearly parallel with one another, and anastomose with the anterior intercostal branches of the mammary artery.

635. The aorta, after having passed between the crura of the diaphragm, rests on the bodies of the lumbar vertebræ as far as the fourth, where its division takes place. Its anterior surface is successively in apposition with the liver, the pancreas, duodenum, and mesentery. The vena cava accompanies it, lying at its right side. The branches of the abdominal aorta are divided into two sets—1. Those which arise from its forepart and singly, viz. the cœliac, superior, and inferior mesenteric. 2. Those which pass off in pairs, viz. the phrenic, renal, capsular, spermatic, and lumbar.

1. The *cœliac artery* arises from the aorta, whilst between the crura of the diaphragm. In the erect position of the body its direction is horizontally forwards, but is not more than half an inch long. It is concealed by the lesser omentum, and lies close to the left side of the lobulus Spigelii, and above the pancreas, the two semi-lunar ganglia being in apposition with it on either side. It gives off three remarkable branches; viz. the coronaria ventriculi, the hepatic, and splenic.

a. Arteria coronaria ventriculi, the smallest of the three, inclines upwards, and to the left side, to reach the cardiac orifice of the stomach. At this point some ramusculi are sent upwards on the œsophagus, which communicate with the aortic œsophagean branches; others pass before and behind the cardiac extremity of the stomach, which they coil round. The continuation of the vessel inclines from left to right along the lesser curvature of the stomach, and inosculates with the pyloric branch of the hepatic artery.

2. *Arteria hepatica* passes upwards, and to the right side, to reach the transverse fissure of the liver, in which course it lies in front of the vena portæ, and to the left of the hepatic duct. Previously to reaching the liver, it gives the following branches:—

a. Arteria pylorica descends to reach the pyloric end of the stomach, and then turns along its lesser curvature, about the middle of which it inosculates with the coronary artery: it is sometimes a branch of the following:—

b. Arteria gastro-duodenalis descends behind the duodenum near the pylorus, and on reaching the lower border of the stomach, changes both its name and direction. It runs from right to left along the great curvature of the stomach, between the lamellæ of the great epiploon, assuming the name of *gastro-epiploica dextra,* and inosculates with the gastro-epiploica sinistra derived from the splenic artery. It gives several small branches to the duodenum and pancreas: one, larger than the rest, is called *pancreatico-duodenalis,* and takes rather a semi-circular course along the inner margin of the duodenum, distributing branches to it and the pancreas, and communicating with some small branches of the superior mesenteric artery.

Near the transverse fissure the hepatic artery divides into its right and left branches, which are intended for the supply of the corresponding lobes of the liver. From the right branch arises a ramusculus *(cysticus)*, which passes along the left side of the gall-bladder to its fundus, to ramify upon its coats, and in the substance of the liver.

3. *Arteria splenica*, in the adult, is the largest branch of the cœliac. It passes along the border of the pancreas, to which it gives several ramusculi, and near the spleen divides into several branches. Some of these enter the fissure in that organ, and are distributed to its substance; three or four are reflected towards the bulging end of the stomach, in which they ramify: the latter are called *vasa brevia*. Finally, a remarkable branch inclines from left to right, to reach the great curvature of the stomach, lying between the lamellæ of the great epiploon: hence it is named *gastro-epiploica sinistra*. It inosculates about the middle of the curve with the gastro-epiploica dextra, which is derived from the hepatic artery.

The *superior mesenteric artery* arises from the forepart of the aorta, a little below the cœliac. Its root separates the pancreas from the transverse part of the duodenum; its continuation lies between the lamellæ of the mesentery. This vessel at first inclines downwards, and to the left side, but afterwards changes its direction, running transversely towards the right iliac fossa, opposite to which it inosculates with the ileo-colic branch. It thus describes a curve, whose concavity looks to the right side, so that its branches may be divided into two sets, viz. those which arise from its convexity, and those from its concavity. *a.* Those which spring from the convex side of the vessel are all intended for the supply of the jejunum and ileum. They are usually from sixteen to twenty in number. They run parallel to one another for some way, and then each divides into two branches, each of which forms an arch, with a similar offset from the neighbouring branch. From the summit of the first set of arches, branches issue, which divide, and re-communicate in the same way, until, finally, after forming four or five such tiers of arches, each smaller than the other, the ultimate branches proceed directly to the intestines, and ramify in their coats. *b.* The branches from the right side of the mesenteric artery are given to the large intestine. The first, or *ileo-colica,* (taking them in their order from below upwards,) inclines downward, and to the right side, towards the ileo-colic valve, near which it divides into two branches; of these, one arches down, to inosculate with the termination of the mesenteric artery itself, and from the convexity of the arch branches go off to the intestines, particularly to the valve; the other branch ascends, and inosculates with the following branch: the *colica dextra* passes transversely to the middle of the ascending colon, opposite to which it resolves itself into two branches, of which one descends to communicate with the preceding, whilst the other ascends to join in an arch with the succeeding: the *colica media* passes upwards to the transverse colon, and divides in a manner exactly similar to the vessels just noticed. One of its branches inclines to the right, where it inosculates with the preceding vessel; the other descends to the left side, and maintains a similar communication with the colica sinistra, derived from the inferior mesenteric artery. From the arches of inosculation thus formed, branches pass to the intestine, for the supply of its coats.

The *inferior mesenteric artery* arises from the aorta, about an inch above its termination. It inclines downwards to the left iliac fossa to reach the sigmoïd flexure of the colon, from which it descends into the pelvis, and, under the name of superior hæmorrhoidal artery, passes behind the rectum. Its branches are, *a, colica sinistra,* which, close by the descending colon, divides into two branches, similar to those of the colic vessels of the opposite side. One of these branches passes upwards along the colon, and inosculates with the descending branch of the colica media. The descending branch passes along the sigmoïd flexure, to which it sends ramusculi *(sigmoïdei).* These sometimes arise separately from the colica sinistra. The continuation of the vessel having assumed the name of *hæmorrhoidalis superior,* lies in the fold of the meso-rectum, and ramifies in the coats of the intestine, communicating with the middle and inferior hæmorrhoidal arteries. We shall find, on even a slight inspection, a continued chain of anastomosis, from one end of the alimentary canal to the other.

The colic arteries form a vascular circle along the great intestine. The branches from the convex side of the mesenteric artery establish another range of arches along the small intestine, which is connected to the former by the ileo-colic artery. The superior mesenteric again anastomoses by some branches with the pancreatico-duodenalis; the latter, at its root, is in a manner continuous with the pyloric artery, and so on, through the coronary, and its ascending branches, a similar connexion is formed with the œsophagean branches, even up to the pharynx.

The branches of the abdominal aorta, which arise by pairs, are:

1. *Arteriæ phrenicæ.* Though these usually arise from the aorta, one sometimes comes from the cœliac. They pass outwards, diverging from one another, and run for a short way on the crura of the diaphragm, after which they ascend upon the broad part of that muscle, freely ramifying in its structure.

2. *Rami capsulares* are two or three small twigs, which supply the supra-renal capsules.

3. *Arteriæ renales,* vel *emulgentes,* are two considerable trunks, which issue from the sides of the aorta, between the superior and inferior mesenteric arteries. The right is longer than the left, and passes behind the vena cava. Previously to reaching the concave border of the kidney, each artery divides into five or six branches, which ultimately subdivide into ramusculi, and form, by their interlacement, the cortical part of the organ. These arteries are concealed by the corresponding veins.

4. *Arteriæ spermaticæ* are scarcely so large as a crow-quill: they start from the aorta at an acute angle, just below the renal arteries; the left sometimes arises from the corresponding renal artery. Each of these rests on the psoas muscle, inclosed between two small veins; and, at the lower part of the abdomen, it turns forwards to gain the internal abdominal ring, where it comes into contact with the vas deferens, with which it proceeds to the testis: close by that organ, the artery divides into branches, some of which supply the epididymis, others the body of the testis.

5. *Arteriæ lumbales* are five in number, and pass off laterally from the aorta, at right angles with it. These vessels lie on the bodies of the lumbar vertebræ, concealed by the psoas muscles. On arriving opposite the roots of the transverse processes, each

divides into two branches. One of these passes backwards, and ramifies in the mass of lumbar muscles; but it previously sends some twigs through the intervertebral foramina to the dura mater and medulla spinalis. The other branch proceeds outwards, behind the quadratus lumborum, and then between the abdominal muscles, to which it is distributed.

The *sacra media* arises from the extremity of the aorta, just at its bifurcation. From this point the artery proceeds downwards upon the last lumbar vertebra, and over the middle of the sacrum, as far as the coccyx, where it forms small arches of anastomosis with the lateral sacral arteries.

The *sacra lateralis* arises from the internal iliac artery, and runs parallel with the preceding to the coccyx, where they anastomose. It sends several branches through the sacral foramina. The middle hæmorrhoidal artery also arises from the iliac, and passes inwards to reach the rectum, on which it is distributed. The vesical arteries issue from the same source, and supply the fundus of the bladder. The uterine and vaginal arteries pass inwards to their respective organs, being also derived from the internal iliac. These are all small branches, and subject to many variations in their course and mode of distribution.

636. The *inferior vena cava* returns the residue of the blood circulated by the descending aorta. It commences at the conflux of the two common iliac veins on the side of the fourth lumbar vertebra, and thence ascends along the right side of the aorta, as far as the posterior border of the liver: it there becomes lodged in a groove in that organ, after which, it inclines forwards to reach the opening in the diaphragm appropriated it, and finally terminates in the right auricle. In its course it receives the veins corresponding with the lumbar, spermatic, and renal arteries; and, finally, the hepatic veins, which, through the medium of the vena porta, return the blood from the chylopoietic viscera.

637. The *superior vena cava* commences at the conflux of the two venæ innominatæ, which occurs behind the right margin of the first bone of the sternum, and midway

between the cartilages of the two first ribs. Each vena innominata results from the union of the subclavian and internal jugular veins, behind the sterno-clavicular articulation. That of the right side is short and perpendicular in its direction, the left runs obliquely, and both join at the point above indicated. Thus the superior cava returns the blood from both sides of the head, and from the upper extremities. After entering the pericardium, it lies on the right side of the aorta, until it opens into the right auricle.

638. The *vena azygos* forms a connexion between the venæ cavæ; it issues either from the inferior cava, where it turns forwards to reach the opening in the diaphragm, or from one of the lumbar veins; sometimes from the renal. This vein enters the thorax through the aortic opening in the diaphragm, and runs upon the bodies of the vertebræ, until it arrives opposite the root of the right lung, round which it turns, forming an arch, whose concavity looks downwards. Its termination opens into the superior cava, where it becomes invested by the pericardium. In this course the azygos vein receives those from the intercostal spaces, and also a small vein called *azygos minor*. This commences from the left renal vein, or from one of the lumbar veins, and having entered the thorax with the aorta, or through the crus of the diaphragm, runs on the spine, and opens into the preceding, opposite the fifth or sixth dorsal vertebra.

639. The *thoracic duct* commences opposite the second or third lumbar vertebra by a slight ampulla (*receptaculum chyli.*) To this point converge three or four lymphatic vessels, formed by the union of those of the lower extremities with the lacteals that ascend from the intestines. The duct enters the thorax through the aortic opening, and lies between the aorta and vena azygos. In its ascent it passes behind the arch of the aorta, and then between the left carotid and subclavian arteries, so as to reach the neck, where it makes a turn downwards and forwards, to

open into the angle formed by the union of the subclavian and internal jugular veins. On the right side a short trunk opens into the same part of the corresponding veins; it is named the *right lymphatic duct*, and is formed by the junction of the lymphatic vessels of the right upper extremity, and of the corresponding side of the neck and face.

640. The *dorsal nerves* consist of twelve pairs; the first issues through the invertebral foramen, between the first and second dorsal vertebræ, the last between the twelfth and the first lumbar. Immediately after their exit, each of them divides into two branches, one of which (*posterior*) passes backwards, between the transverse processes, and is distributed to the dorsal muscles; the other (*anterior*), after communicating with the gangliac nerves, runs forwards in the corresponding intercostal space, and insinuates itself between the lamellæ of the intercostal muscles, to which it gives several filaments. The terminal branches of these nerves may be traced to the forepart of the thorax, where they are finally lost; some of the lower ones extend to the abdominal parietes. From the second and third, two filaments, after piercing the intercostal muscles, pass across the axilla, and descend on the back part of the upper arm, and hence have been named the *intercosto-humeral* nerves. The dorsal nerves are usually called the intercostals, from their position with regard to the ribs.

641. The *œsophagus* is a musculo-membranous tube, extended from the lower end of the pharynx to the stomach. Commencing opposite the cricoïd cartilage, to which its fibres are attached, it descends behind the trachea, deviating, however, a little to the left side: in the thorax it rests on the vertebral column, inclining at first towards the middle line; but as it descends it will be observed gradually to incline forwards and to the left side, so as to reach the œsophagean opening in the diaphragm. Whilst in the neck, the trachea and recurrent nerves lie in front

of it, and the cervical vessels on each side. In the middle of the thorax it is close by the right side of the aorta, and there becomes invested by the plexus formed by the vagus nerves; lower down, it passes over the aorta, as has been stated. The tube is lined by mucous membrane, which is invested by a muscular tunick composed of longitudinal and circular fibres.

642. The *thymus gland* in the adult is very irregular in its form, and differs little in appearance from common cellular tissue. In the fœtus it extends from the diaphragm to the thyroïd gland; its substance is lobulated, and its extremities divided into two processes.

The vascular system is made up of a multitude of membranous tubes (*vessels*), some of which convey, to the different organs and structures of the body, the fluids destined for the maintenance of their functions and growth, whilst others receive from the system at large the effete fluid, and carry it back to the point from which it had set out. As the fluids, in the greater number of animals, are thus made to flow, as it were, in a circle, the system of vessels which directs their course is called *circulating*, and the whole process, *circulation*.

These vessels are divided into three sorts; two of which, the arteries and veins, contain blood (though of a different quality in each); the third, the lymphatics, are filled partly with chyle, the product of digestion, and partly with lymph, the residue of nutrition. As the lymphatics terminate in the veins, and pour their contents into them, they may be considered as tributaries to the venous system. The blood, brought back by the veins to the heart, is conveyed onwards from it, by the pulmonary artery, to the lungs, from whence it is returned to the heart again, to be propelled through the aorta into the system at large. Two streams may thus be said to begin and to terminate at the heart: one flowing from it to the lungs by the pulmonary artery, and returning by the veins; the other extending through the whole body, and returning by the venæ cavæ: the former has been termed the lesser, or pulmonary; the latter, the greater or aortic circulation. Though some of the older anatomists had conceived sufficiently correct notions of some parts of the circulating system, yet none of them were able to combine these parts together, so as to form a connected whole: that was reserved for Harvey, who, about the year 1619, first described the true course of the blood in the different orders of vessels, and demonstrated the correctness of his opinions by a complete series of proofs and experiments.

The division of the circulation into the greater and the less, or the pulmonary and aortic, as established by Harvey, continued to be universally received, until Bichât (not by any means with a view to question its correctness or truth,) adopted another, on physiological grounds. The blood in the branches and trunks of the venæ cavæ, in the right side of the heart and pulmonary artery, being of a reddish brown colour (*venous*), that in the pulmonary veins, in the left side of the heart, and likewise in the aorta and its ramifications, being red (*arterial*), suggested to the mind of this great physiologist a corresponding division of the circulation into that of the *red* and that of the *dark* blood. According to Harvey, the heart, placed at the commencement of each circle, receives the blood, and propels it forwards, to describe the greater and the lesser course. According to Bichât, the heart must be conceived to be situated mid-way between the origin and termination of each system; of which one (the dark blooded) begins in the general capillary system of the body, and terminates in the capillaries of the lungs; whilst the red blooded commences in the latter vessels, and ends in the capillaries diffused throughout the body. In this view of the subject, the actions of the lungs, and those going on in the body generally, may be considered as maintaining a constant antagonism, the one purifying and restoring the blood which had been deteriorated by the other.

The formation and development of the vascular system have been examined of late years with the greatest attention by several physiologists, particularly by Meckel, Serres, and Home, whose researches have thrown considerable light on this rather complex subject. Meckel has directed his inquiries for the most part to the following points:—to ascertain the parts of the system which are first developed; the arrangement of these parts in the earlier stages of fœtal life; the relation which exists at different periods between the greater and lesser circulation, the dark and red blooded system; and, finally, the proportion subsisting between the number, size, and capacity of the different orders of vessels at different periods of life.

It is difficult to determine with precision which part of the vascular system is first developed. But if the analogy between birds and the higher animals be sufficiently close to allow of an inference, deduced from observations on the development of the one to be applied to the other, it may be stated that the veins of the vesicula umbilicalis are the first which become manifest; for the vesicula umbilicalis in the human embryo corresponds with the membrane of the yolk, or the yolk-bag in birds, and it is demonstrable, that the veins which issue from the latter are the first that are developed. The vesicula umbilicalis is a minute membranous sack, placed between the chorion and amnios, and greater in size, relatively to the fœtus, the earlier it is examined. It appears to be formed before the new being, which in a manner rests upon it, the vesicula being closely in contact with its anterior surface. The cavity of the vesicle most probably communicates with that of the intestinal canal, but there is evidently a connexion by vessels between it and those of the mesentery up to the second month: these, consisting of an artery and a vein, extend in the first instance from the vesicula to the mesenteric vessels. At the period just referred to they reach no farther than the parietes of the abdomen, and finally they disappear altogether. From their mode of connexion, these vessels are called *vasa omphalo-mesenterica.*

At the earliest period at which either structure or vessels become perceptible in the chick, some small rounded vesicles, or rather spaces, are seen in the membrane of the yolk, which soon become filled with a clear and viscid fluid. Separated from one another at first, they represent so many islets, or rather a chain of vesicles, gradually increasing in number, until they form a network, which soon becomes filled with blood in place of the fluid previously contained. The minute radicles thus formed gradually unite to form branches, which coalesce and form a trunk—the omphalo-mesenteric vein. These are properly but rudimentary vessels; they have no proper coats, they are merely canals hollowed, as it were, in the texture of the membrane, like the canals observed by Sir E. Home in a clot of blood, marking out the course of the vessels about to be developed within it. The substance of the membrane becomes thickened along the course of these canals, and forms the first rudiment of their walls; and then the process of development goes on progressively, though slowly. When the omphalo-mesenteric vein is thus formed, it turns from below upwards, situated anteriorly with regard to the body of the embryo, and terminates in a vein which ascends perpendicularly, and presents a dilatation at the point where the heart is ultimately produced. From this the aorta issues, and distributes branches to the different organs of the body, the accompanying veins being formed nearly at the same time, and also the omphalo-mesenteric artery. It is more than probable that the umbilical vein and artery are developed in the same order as the omphalo-mesenteric vessels, viz. the vein first, the artery afterwards; for they in a manner supplant them. Though arguments founded on analogy so often lead to error that it is hazardous to employ them in researches of this sort, we yet may use them for the illustration of our views, if not for their confirmation. During the germination of seeds the new plant, in the first instance, is observed to derive its support from the farina of the seed, and from the leafets developed within the cotyledons. When the radicula has shot down, and begins to derive nutriment from the soil, these leafets perish, and the plant is supplied by its own roots. So the vesicula and its vessels support the embryo until the umbilical veins are formed, after which it withers, and finally disappears, when the latter have established their connexion with the uterus through the medium of the placenta.

The vein (*omphalo-mesenteric*) derived from the vesicula, opens into the mesenteric vein of the fœtus, which is a primary branch of the vena portæ, so that the latter may be regarded as derived from the omphalo-mesenteric vein. The vena portæ, at this stage of fœtal existence, forms the principal trunk of the venous system, and ascends towards the point afterwards occupied by the heart, where it presents a slight ampulla, corresponding with the auricle. The heart appears at first in the form of a slight annulus, the left ventricle being the part earliest recognized, immediately above which the aorta is produced, in the form of a small dilatation.

These vesicular dilatations are for a while separated by narrow interstices, but they gradually approach and become united. At first we find but two small cavities, representing an auricle and a ventricle, which are ultimately divided each into two chambers, by the development of a transverse septum. Whilst these changes are going on, progress is at the same time being made in the development of other parts of the vascular system. The vena portæ, which originally lies behind the liver, and unconnected with it, becomes connected with the umbilical vein, and conjointly with it ramifies in that organ, which then encloses the vein, and for the first time becomes a sort of diverticulum, in which the blood circulates before it passes to the heart. Cases have occasionally occurred in which the liver and vena portæ continued to retain the relative position above indicated; that is to say, the vein passed behind the liver without possessing any connexion with it, and opened directly into the vena cava. In these instances a fluid, resembling bile, was found in the gall-bladder, and the inference was at once deduced that the bile is in all cases secreted from the blood of the hepatic artery, and not from that in the vena portæ. From what has been just stated, these are merely cases of deranged or imperfect development, and cannot as such furnish legitimate data from which any inference can be drawn. But even were it otherwise, the conclusion would be invalid, on the obvious principle, "haud valet argumentum à particulari ad universalem."

As the development of the heart proceeds, the auricle becomes divided into two cavities (but incompletely), by a septum, which projects inwards from its circumference. The division of the ventricles takes place more slowly, and in a different manner. The right ventricle at first appears like a small tubercle, extending downwards gradually towards the apex of the heart, but still retains a free communication with the left, particularly towards the superior part or base, on which account the aorta is, in the first instance, connected with both ventricles. The pulmonary artery is the last of these central parts which presents the form of a distinct trunk; its course in the first instance is, as it were, slightly sketched out along the aorta, with which it communicates directly by means of the ductus arteriosus, sending, however, a diverging branch to each lung. The ductus arteriosus, it may be observed, is a short canal, which passes from the extremity of the pulmonary artery to the arch of the aorta, and opens into it just opposite the point from which the left subclavian artery arises. By means of this communication, the streams which issue from the two ventricles become blended, at least in part, and so the duct has the same effect on the action of the ventricles that the foramen ovale has on the auricles; it makes them, as it were, a single cavity, and the heart, considered as a whole, becomes, by this double communication, analogous to that of several of the lower animals, in which it consists of one auricle and one ventricle. When the placenta is formed, and the fœtus, through its medium, begins to derive support from the parent, the course of the nutritive fluid is as follows:—A vein (*umbilical*), commencing by branches in the placenta, passes along from it, being in its course coiled round by two arteries (umbilical), which are continuations of the hypogastric arteries of the fœtus, and are intended to carry back to the placenta the residue of the blood that had previously circulated in the body of the new being. The vein having reached the abdomen, passes towards the longitudinal fissure of the liver, in which it runs from before backwards, sending branches chiefly to the left lobe. At the transverse fissure it forms a direct inosculation with the vena portæ, so that the currents of the two veins are mingled at that point, after which they circulate in the liver. The remainder of the blood brought by the umbilical vein is carried onwards to the vena cava by the ductus venosus (which is lodged in the posterior part of the longitudinal fissure), and so to the heart. Were it then required to indicate the course of a given quantity of blood derived from the placenta, and circulated through the fœtus, it would be found as follows: When brought to the liver by the umbilical vein, part is given to that organ (its left lobe) without mixture, and part, after being mixed with that of the vena portæ, whilst the rest, by means of the ductus venosus, is conveyed to the vena cava, and so to the right auricle, mingled with the blood of that vein. The current passes directly backwards through the foramen ovale into the left auricle, and thence into the left ventricle. From the last named cavity it is propelled through the aorta, and its ascending branches, into the head and upper extremities, a small part only being conveyed downwards into the descending part of the aorta. Now, the blood which is brought back from the superior parts of the body and the head, by the jugular and subclavian veins, to the right auricle, passes, during the earlier periods, without any intermixture with the blood of the inferior cava, into the right auricle, and thence into the corresponding ventricle, which, by means of the pulmonary artery, propels it partly into the lungs, but chiefly through the ductus arteriosus, into the descending aorta, and so into the inferior parts of the body. This descending current consists of a less pure fluid than that circulated by the superior aortic branches, as most of it had already circulated through the superior parts of the system of the fœtus, the rest being merely that portion which is conveyed downwards from the arch of the aorta, after having sent the chief part of its blood upwards into the subclavian and corotid arteries. The iliac vessels, into which the aorta divides inferiorly, convey the blood into the lower extremities; but the greater part of it is sent, by the umbilical arteries, to be circulated in the placenta. And as, in after life, the capillaries of the lungs and those of the general system are opposed to one another, so, during fœtal life, a similar antagonism is maintained between the capillary system of the embryo and that of the placenta. The blood at this early period describes two circles, which intersect one another, and communicate at the heart, so as to describe (to use Bichât's expression) the figure 8.

At first, as has been stated, the blood of the superior and that of the inferior cava do not intermingle in the right auricle: but as the valve of the foramen ovale increases, and narrows the passage into the left auricle, some part of the blood of the inferior cava being prevented from flowing in that course, mixes with that of the descending vein, and with it is conveyed into the right ventricle, so that a gradual approximation is thus being made towards that condition and arrangement of the circulating system which obtain in after life. The peculiarities which mark each of the organic systems of the fœtus, as well as that now under consideration, lessen as it approaches the period in which it is destined to pass from a dependent, and, as it were, parasitic existence, to a separate and independent one. The derivative passages (ductus venosus and arteriosus, the umbilical vein and arteries), which connect all the parts of the circulating system, gradually diminish, and the placento-fœtal arrangement approximates so nearly to the aorto-pulmonary, that the creature is prepared to pass from one mode of existence into the other without disturbance or injury to its yet tender and delicate organization.

The most marked peculiarities of arteries reside in their middle coat, which has been variously named—"proper"—"muscular"—"fibrous." It consists of pale fibres, coiled obliquely round the circumference of the vessels, but none of them forming a complete circle. If an artery be stretched transversely, it will recoil and resume its original diameter; if elongated, it will retract. These are direct proofs of elasticity. When an artery no longer carries blood, as, for instance, when a ligature has been applied upon it, the part beyond the ligature will contract, its tube will become obliterated, and, finally, by an alteration in its mode of nutrition, will degenerate into a mere fibrous cord. This indicates a contractile power different from that resiliency which characterizes structures simply elastic, and may be termed contractility of tissue, to denote that it is in some sort a vital property. The coats of arteries resist the effects of maceration for a considerable time, and yield on decoction but little gelatine, and no fibrine: hence the structure of their middle coat has been assimilated to that peculiar substance called "tissue jaune"—"elastique," which forms the ligamenta subflava of the vertebræ, and the cervical ligaments in the lower animals. These physical and chemical properties constitute a marked line of distinction between the middle coat of arteries and muscle, but in some particulars, more especially in its vital properties, it manifests several points of resemblance to the muscular structure, so that it seems to constitute an intermediate link between it and the fibrous or fibro-cellular tissues. That property of arteries which has been just alluded to, and which enables them to contract towards their centre, without having been previously distended, has been the subject of many controversies amongst physiologists. It has been variously denominated, by different persons,—tonicity, vital force, contractility, &c. The whole controversy may be reduced to this—are all the phenomena of extension and contraction that are presented by arteries attributable solely to their elasticity? Haller, Bichât, and Majendie, have taken the affirmative side of the question; Hunter, Sœmmerring, Thomson, and Home, the opposite. A decided difference of opinion between such high authorities affords abundant evidence of the difficulty of the subject, particularly when we consider the great attention which they have severally paid to it, and the many experiments which they performed with a view to arrive at some satisfactory conclusion. Bichât's arguments against the irritability of arteries are as follow:—1. Mechanical or chemical irritants, applied to their external or internal surface, determine no contraction in them; nor, when divided longitudinally, do the edges of the incision become everted, as occurs in the intestines, or other irritable tubes. 2. When separated from the body they manifest no signs of contractility: if the finger be introduced into a vessel, it is not compressed. Galvanism produces no contraction; and if any is caused by the application of an acid, it is attributable rather to its chemical action on their coats than to any vital power in them. "The arteries," says Magendie*, "no where present any indication of irritability; they remain immoveable under the action of sharp instruments, of caustics, and of the galvanic current."

These results are not by any means conformable with those obtained by other physiologists. Dr. Thomson† "succeeded in producing complete contraction, by irritating, for some time, though gently, with the point of a needle, the small arteries in the web of a frog's foot." The same effect was also produced by weak volatile alkali; but when a saturated solution of common salt was applied, with the point of a hair-pencil, "the arteries, instead of being contracted, as they had so uniformly been by the application of ammonia, were actually and sensibly dilated‡." Again: "when the capillaries are stimulated by the direct rays of the sun, the application of gentle friction, or of spirits of wine, the velocity of the blood in them is immediately increased§." The application of electricity has determined marked contractions in arteries, as has been observed by two Italian physiologists, Giulio and Rossi; and Sir E. Home succeeded in producing the same effect by irritating a neighbouring nerve. These direct proofs of the irritability of arteries derive additional support from several pathological facts. "The increased pulsation of the larger vessels, supplying an inflamed part, sufficiently evinces their increased action*." Thus, if paronychia occur in one of the fingers, the corresponding radial artery will pulsate more strongly than that of the opposite hand. In cases of hemiplegia the force is considerably diminished at the affected side, though it remains quite natural at the other, a proof that the arteries possess a power independent of the heart, and which is attributable to their irritability. The degree in which these two properties of arteries, elasticity and irritability, are manifested, differs according to the size of the vessels; the larger are more elastic, the smaller more irritable. This latter property is more or less subjected to nervous influence: towards the decline of life, both gradually diminish.

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* *Physiology*, p. 415.

† *Lectures on Inflammation*, p. 85.

‡ *Eod. loco.*

§ WILSON PHILIP *on the Vital Functions*, p. 285.

Harvey imagined that the heart was the sole agent in carrying on the circulation. According to his view of its mechanism, the impulse communicated to the blood, at each contraction of the ventricles, is sufficient to overcome not only the obstacles in the arterial half of the circle, but also to bring up to the right auricle the current of blood, forcing into it, at one side, a quantity equal to that expelled at the other. According to this hypothesis too much was attributed to the heart, and too little to the arteries: still it formed the basis of some very elaborate calculations, entered into to shew the power of the heart, by estimating the quantity of resistance it had to overcome; but the total discrepancy in the results shewed the inadequacy of the data on which the calculations were founded. Borelli estimated the heart's force as being equal to 135,000 pounds; whilst Keill reduced it to 5 ounces†. That the vessels assist in carrying on the circulation may be inferred from the following facts:—1. They appear before the heart in the human embryo; and in several of the lower animals, in which there is no heart, the vessels alone propel the fluids. In fishes there is no aortic ventricle; in reptiles the arteries contract and propel the blood after the heart has been removed; and even in warm-blooded animals this has been observed undiminished in the capillaries, after all connexion with the heart had been cut off by a ligature on the aorta*. The circulation goes on in acephalous monsters, though they have not a heart. Inferences drawn from a consideration of the structure and functions of the lower animals cannot always be extended to those of more complex and perfect organization, as the analogy between them may not be sufficiently close to warrant the application; but from a general view of what has been stated with regard to the circulating system, we may conclude, that when the heart exists it exerts a decided influence on the circulation; that, by its action, the flow of blood in the arteries moves on, not continuously, but in jets; and that it continues uninterruptedly, though the leading arterial trunks have become ossified. The vessels also have a part to perform, as is evident from the fact, that they can propel the blood after the heart has ceased to act, and so the heart and arteries may be considered as associated for the performance of a special function, each being to a certain extent endued with an independent power; one acting by direct propulsion, the others assisting by their vital force and elasticity.

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* *Thomson, Loc. cit.*

† *Essay on several Parts of the Animal Economy, by* J. Keill, pp. 80—87.

The flow of blood in the arteries determines a peculiar phenomenon, called *pulse*. The number of arterial pulsations in a given time, varies according to the age, sex, and constitution of each individual; but, setting aside these, and all other variations dependent on different circumstances, in health as well as in disease, when we come to inquire what is the change sustained by arteries during their pulsation, and what is the cause of that change, we find that even on these preliminary questions a considerable difference of opinion exists amongst physiologists. According to Mr. Hunter†, "arteries, during their diastole, increase much more in length than width. It is, however, the increased diameter that is perceived by the touch. This increase is so manifest as to be felt or seen, and produces what is called the *pulse*." According to Dr. Hales*, "at each systole of the heart the blood in the arteries is propelled forward with an increased impetus, thereby dilating the canal." Dr. Thomson's opinion is nearly to the same effect:—"The pulsation of arteries is derived entirely from the dilatation and elongation which they experience, from the blood impelled into them by the systole of the heart†." Haller, in one part of his Elements, attributes the pulse to a dilatation of the arteries, but subsequently admits that the dilatation cannot be perceived, and is only inferred from the sensation communicated to the finger. Bichât, during the progress of his researches, frequently examined the condition of denuded arteries, and as he could not observe any adequate dilatation in them, he came ultimately to the conclusion that the pulse was attributable to a locomotion in the whole artery, ("un mouvement de totalité‡,") which causes it to spring against the finger during the systole of the heart. Yet he still inclines to admit a dilatation in some degree: —"Quant à la dilatation, elle est *presque* nulle dans l'état ordinaire." It is scarcely necessary to allude to the hypothesis of Dumas§, that arteries are endued with a power of active dilatation, which enables them to expand, to receive the blood which is about to be propelled into them. The late Dr. Parry‖, of Bath, assisted by Mr. Norman, made a great number of experiments, to determine the condition of arteries during their pulsation. Whilst prosecuting his researches, he laid bare fifty-five of the larger arteries in horses, sheep, and dogs, "yet could not by any mode of scrutiny detect, in a single instance, the smallest dilatation or contraction corresponding with the systole or diastole of the left ventricle of the heart." It is more than probable, as Dr. Wilson Philip has remarked, that the mode of measurement adopted in these experiments was not sufficiently delicate to ascertain the point with precision, for Dr. Hastings found that a ligature placed round an artery was tightened at each contraction of the heart. It appears, then, that the weight of testimony and authority inclines to that opinion which attributes the pulse to a dilatation and elongation of the artery, synchronous with the systole of the ventricles. It cannot be said to be actually dependent on that cause, for if it were, no difference could exist in the state of the pulse in the corresponding arteries in different limbs, neither could it be raised above par, as we frequently find it, in a vessel leading to an inflamed part, nor depressed below it in a paralytic limb.

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* *Enquiry into the Laws of the Vital Functions*, p. 284, *by* WILSON PHILIP.

† *On the Blood and Inflammation*, p. 23.

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* *Hæmastatics.*

† *Lecture on Inflammation*, p. 63.

‡ *Anatomie Generale*, vol. ii. p. 335.

§ *Physiologie*, vol. iii. p. 314.

‖ *Essay on the Pulse.*

CHAPTER IX.

SECTION I.

NERVOUS SYSTEM.

643. THE nervous system in the vertebrated animals may be considered as divisible into two parts: one, consisting of cords, or fibrillæ, universally diffused through the body, and called nerves—the other, the central mass in which these nerves terminate. To this, as to a common centre, the nerves convey the impressions which are made by external agencies on their sentient or peripheral extremities, and from it they reconvey the mandates of the will.

631. When viewed as a whole, the nervous system is symmetrical in the strictest sense. It consists of two lateral halves, which, being disposed similarly on each side of the central line, resemble one another in every particular. Thus, the brain is divided into two hemispheres, each presenting on its inferior surface three lobes. The cerebellum also is divided into two lobes, and the medulla oblongata into two lateral halves, each consisting of three fasciculi or bundles of fibres—the division being established by two grooves or sulci, one on its anterior, the the other on its posterior aspect, situated exactly in the median line. These sulci, by being continued along the whole length of the medulla spinalis, divide it also into two symmetrical portions.

632. This symmetrical arrangement extends to the nerves also, so long as they retain the form of distinct cords; but when, at their perepheral termination, they become expanded into, and blended with the minute texture of the different organs which they supply, their mode of distribution altogether eludes our research. We can,

however, infer that their filaments interlace one with another so as to form a net-work, by which a complete and free communication is established between them. Again, when we examine the central parts, we find that each lateral half is connected with the other by certain transverse bands, which are disposed along the middle line, and termed commissures. On this union and connexion between the different parts of the nervous system, by which they become intimately blended at their periphery, as well as towards the centre, the individuality of the animal essentially depends.

644. The central parts of the nervous system are deeply seated, being enclosed within the spinal canal and cavity of the cranium. The nervous cords, too, are in a great degree withdrawn from the influence of external agencies by the situations in which they are placed during their course. Their final terminations only approach the surface, where, by being expanded on the internal and external teguments, they communicate to these parts their sentient and tactile properties.

645. The nervous system is made up of two substances, readily distinguishable by their colour, texture, and consistence. One is greyish, or rather a pale ash-colour, and thence named *substantia cinerea;* and as in the brain it forms an investment for the white substance, it is usually termed *corticulis*. The other substance is of a pure white colour, and from the relation just indicated, is called *substantia medullaris*. It cannot, however, be said with propriety that the one is external, or the other internal, as their position is reversed in different parts of the system. The grey substance invests the cerebral hemispheres, and forms at the same time several masses disposed in their interior, but in the medulla spinalis it is altogether deeply seated. The white substance, on the contrary, is enclosed by the grey in the brain, but becomes the cortex in the medulla. The cineritious substance is more soft and

vascular than the other, and when minutely injected appears as if entirely composed of vessels. Though the white substance in the natural state is not firmer than jelly, it acquires a great degree of firmness by maceration in spirit, and presents at all times a distinctly fibrous appearance. When examined by the aid of a microscope, both structures are found to consist of a number of globules; and it is rather probable that the fibrous character results from the globules being disposed in linear striæ.

646. The central mass of the nervous system, or, as it is not unusually termed, the cerebro-spinal axis or centre, is made up of several parts, readily distinguishable from one another by their situation, conformation, and structure. 1. The medulla spinalis, or the cord-like prolongation which is lodged in the spinal canal. 2. The cerebral mass, or encephalon, so called from being enclosed within the cranium, and which is subdivided into the cerebrum, cerebellum, and the cerebral protuberance.

647. We shall commence the description of the cerebro-spinal system with that of the medulla, not only because it is the part first developed in the human embryo, as well as in the animal series, but also because we shall be enabled, by taking the parts in the order of their development, to follow more conveniently than could otherwise be done, the course of the fibres as they ascend from the medulla into the brain and cerebellum. With this view, after having examined the fasciculi of medullary fibres, as they are aggregated together in the superior part of the medulla, and where, according to Gall, they may be considered as the primitive or formative fibres of the cranial expansion of the nervous system, we shall trace them upwards as they receive successive additions in the ganglia of increase, until they are finally evolved into the hemispheres of the brain and lobes of the cerebellum.

648. The greater part of the medulla is inclosed within the vertebral canal: the remainder is prolonged into the

skull, and rests on the basilar process of the occipital bone. On this is founded its division into *medulla spinalis* and *medulla oblongata*. In the adult human subject the medulla extends, from the lower border of the pons Varolii, as far as the first or second lumbar vertebra. In the fœtal state it extends throughout the whole length of the spinal canal, conforming in this particular with a permanent condition in the lower animals, in which it reaches even to the caudal prolongation of the column. As the process of growth and development goes on, the relation of the medulla to its osseous canal varies, so that ultimately it reaches only to the point above stated. Keuffel, however, saw it in one case end opposite the eleventh dorsal vertebra, and in another, to reach as far as the third lumbar. Its form, considered in its general outline, is cylindrical; but its transverse diameter is somewhat greater than the antero-posterior, which gives it a flattened appearance in the former direction. The size of the medulla is not the same from one extremity to the other; neither does it increase or diminish uniformly. Three distinct swellings are observable in different parts of its extent. Superiorly it is enlarged where it is in apposition with the margin of the pons Varolii, but gradually diminishes as it approaches the foramen magnum. The second swelling corresponds with the interval between the third and sixth cervical vertebræ; the third with that between the tenth dorsal and the first lumbar. The inferior termination of the medulla is subject to considerable variety in different cases. It usually becomes fusiform, and terminates in a point, a few lines below the lumbar swelling: in other instances, it ends in a small bulb, slightly constricted at its centre: but any varieties of conformation presented by this portion deserve little attention, as none of the nerves arise from it.

649. When detached from its connexions, the medulla is found to be divided into two lateral halves, by sulci extending along its whole length, one situated on the an-

terior, the other on the posterior aspect. The white substance which encircles the two lateral cords of the medulla, dips into the sulci, but it is somewhat remarkable that, in the anterior one, the fibres are observed to pass from side to side, and intermix along the median line; in the posterior one they all pursue the longitudinal direction. At each side of these grooves, two others (*fissuræs laterales*) may be observed running parallel with them, being, however, but faintly marked. These indicate the lines in which the anterior and posterior roots of the spinal nerves are attached to the medulla.

650. The cranial portion of the medulla (*medulla oblongata*) is broad and thick, superiorly, near the pons Varolii, but tapers gradually towards the occipital foramen. Its anterior aspect is rounded, the posterior is somewhat flattened; and, as each presents a continuation of the median sulcus, it is divided into two symmetrical parts. The lateral depressions which correspond with the points of origin of the spinal nerves, are also continued upwards into the medulla oblongata. But though inferiorly the divisions established by these lines are so slightly marked as to have escaped notice, until Chaussier directed his attention to the subject, yet in the superior part (*medulla oblongata*) they are so well defined as to have been deemed deserving of particular names. The anterior and posterior pair have been called the anterior and posterior pyramids; the middle, from their shape, the corpora olivaria. These, according to Gall, are made up of the primitive, or formative, fibres of the cerebrum and cerebellum, for, if they be traced upwards, the anterior pyramids, and the corpora olivaria, will be found continuous with the fibres which are expanded into the cerebral hemispheres, whilst the posterior pyramids (usually called, since Ridley's time, *corpora restiformia*) are evolved into the lobes of the cerebellum. Besides these parts, which have been noticed by all anatomists, Mr. C. Bell has described another,

which is situated between the corpus olivare and restiforme. This consists of a narrow line of white matter, which may be traced along the medulla oblongata, and from thence downwards between the anterior and posterior roots of the spinal nerves. It is but slightly marked in the lower part of its extent, but becomes more perceptible opposite the corpus olivare; after which it narrows, and ceases altogether at the margin of the pons, "not being continued upwards into the cerebral mass." This may be termed *tractus respiratorius*, as it gives origin to the class of respiratory nerves as established by Mr. Bell.

A transverse section of the medulla shews it to consist of a thin lamella of white matter, inclosing the grey or cineritious substance. The latter presents two lateral portions, each of a crescentic form, their concavities looking outwards; the convex sides of each are turned towards the middle line, and are connected by a short transverse fasciculus of grey matter. The anterior cornua of the lateral masses are rather thick and rounded; the posterior extend as far as the corresponding collateral sulci.

651. The *corpora olivaria*, when stripped of their medullary lamella, are found to consist each of an oblong mass of grey matter, surrounded by a fringed or scalloped border, and attached towards the middle line by a slight petiole. Owing to this arrangement, it presents, when divided by a transverse section, an arborescent appearance.

652. The *corpora pyramidalia* are separated only by the anterior sulcus, and extend, inclosed between the corpora olivaria, from the margin of the pons to the foramen magnum. Those fibres of each pyramid which are close to the sulcus, pass across it obliquely, and so a decussation is produced between them. The rest continue their course uninterruptedly, so that only a part of the pyramids change place, or decussate.

653. The *corpora restiformia* (*pyramides posterieures*,

The Brain.

655. The brain forms the largest portion of the central mass of the nervous system, and occupies the principal part of the cranial cavity. It extends from the frontal bone to the occipital fossæ, resting on the orbital processes of the former, on the tentorium cerebelli posteriorly, and in the centre descends into the middle fossæ, at the base of the skull. Its superior surface is convex and arched, corresponding with the vault of the cranium, beneath which it is placed, and presents along the middle line a deep fissure, running from before backwards, by which it is divided into two equal parts (*hemispheres*). The surface of the brain is rendered unequal by several depressions and elevations marked upon it. The elevations are called *convolutions* (*gyri*), and are situated between the depressions (*sulci*). The course of the convolutions is winding and tortuous, as the name implies, and their size presents many varieties in different places. It should be observed that the anterior extremity of the brain, which corresponds with the frontal bone, is narrower than the posterior, which is received into the occipital fossæ.

656. The external surface of each hemisphere is convex in its general outline; the internal is flat and compressed, as it rests against its fellow of the opposite side, the falx major being interposed between them. The inferior surface presents several depressions and inequalities, corresponding with those of the base of the skull. On this surface is observed the division of the hemispheres into three lobes. The anterior lobe rests on the orbital process of the frontal bone and the lesser wing of the sphenoïd bone; the posterior is supported on the tentorium cerebelli; and the middle is received into the central fossa, at the base of the skull. The anterior is separated from the middle lobe by a deep fissure (*fissura Sylvii*), but there is

no precise line of demarcation between the latter and the posterior. The relation of size, form, and situation of the different objects seen on the external surface of the brain, should be carefully noted, as allusions are constantly being made to them during the description of the parts deeply seated, and also when tracing the progress of its development in the human subject, or in the animal series, and particularly when, after the manner of Gall and Spurzheim, we follow the course of the nervous fibres through the successive steps of their expansion, from the medulla upwards into the cerebral hemispheres. Nothing of consequence remains to be noticed on the superior and external surface in addition to those already alluded to. The inferior surface presents in the middle line, and in front, a fissure, being the continuation of the longitudinal one, which establishes a separation between the hemispheres. It lodges the anterior extremity of the falx cerebri, and its depth is limited by the corpus callosum, which passes across from one hemisphere to the other. The inferior surface of each anterior lobe, as it corresponds with the orbital plate on which it rests, is slightly concave. A few lines external to the longitudinal fissure, and parallel with it, is a groove, resembling one of the sulci, which lodges the olfactory nerve, and at its posterior extremity is a rounded papilla, from which one root of that nerve is derived. Posterior to this groove is the fissure (*fissura Sylvii*) which marks the separation between the anterior and middle lobes, and lodges the middle artery of the brain. It inclines from within outwards and upwards, and gradually terminates amongst the convolutions on the exterior of the hemisphere, its direction corresponding with that of the smaller wing of the sphenoïd bone. At its internal termination it forms a right angle with another fissure, which extends from before backwards, and which is bounded externally by the middle lobe, internally by the crus cerebri and tractus opticus, and deserves notice because it transmits the pia mater from the external surface into the lateral ventricle. The angular part of the anterior lobe, which is included between the internal termination of the fissure of Silvius, the longitudinal fissure, and the commissure of the optic nerves, has been named by Vicq-d'Azyr, *substantia perforata antica*, and by Reil, *lamina cribrosa*, because it presents several foramina for the transmission of vessels. It deserves attention, inasmuch as the white lines seen at its inner border are derived from the corpus callosum.

657. Between the fissuræ Sylvii, and corresponding with the interval between their internal terminations, is situated the *commissure of the optic nerves*. It is flat and quadrilateral in its form: one surface looks upwards to the brain, and is connected with the anterior termination of the corpus callosum, which passes upon it in the form of a thin semi-transparent lamella; the other surface looks down upon the processus olivaris of the sphenoïd bone; the lateral and anterior margins are free, but the posterior one is intimately connected with a delicate stratum of grey matter, which is inserted between the nerves as they converge to their commissure. This is called by Soëmmering *tuber cinereum*: it extends from the posterior margin of the commissure to the corpora albicantia, gradually becoming a little thicker and firmer, for in front it is so thin as to be torn on the slightest touch. Its superior surface forms part of the floor of the third ventricle; the inferior one is slightly convex, and gives attachment by its centre to a funnel-shaped process, called *infundibulum*. This is a thin elongated process of reddish grey matter, inclined obliquely downwards and forwards from the tuber cinereum to the pituitary gland: its extremities are slightly expanded, and its centre constricted, which gives it an hour-glass shape. The *pituitary gland* is lodged in the excavation in the body of the sphenoïd bone, and is unequally divided into two portions or lobes: the anterior, which is larger and more firm than the other, is convex in

front, and concave behind, so as to receive the other, whose border is round and convex. The situation of the pituitary gland is peculiar: it is interposed between the two lamellæ of the fibro-serous membrane. The dura mater will be found to line the surface of the bone on which the gland rests, but the arachnoïd membrane, after having formed a funnel-shaped process round the infundibulum, is reflected off from it at its lower extremity, and stretched across the upper surface of the gland until it reaches the clinoïd processes, where it becomes continuous with the inner lamella of the fibro-serous membrane.

658. Immediately behind the tuber cinereum are placed two small bodies, called *corpora albicantia* (*mamillaria, pisiformia*). Their size is about that of a pea, but they are not quite round, being slightly compressed on three sides. Placed in apposition with one another, they are connected by a delicate process of grey matter, of which substance the greater part of their mass consists; they are, however, invested by a lamella of white matter, derived from the anterior pillars of the fornix, of which they may be regarded as the termination. Behind these bodies is situated a thin lamella of white substance, which is pierced by a number of foramina, for the transmission of vessels, and called *locus perforatus*, and sometimes *pons Tarini*. Its shape is triangular, the sides being formed by the crura cerebri, the base by the mammillary bodies, the apex being at the border of the pons Varolii: it forms part of the floor of the third ventricle. The *crura cerebri* are two thick rounded bodies, about three-fourths of an inch long, and situated towards the centre of the base of the brain, from which they project rather prominently. They are extended from the pons Varolii forwards and upwards to the under surface of the hemispheres, into which they seem as if inserted. They are in close contact behind, but diverge so as to leave an interval, which is filled by the locus perforatus.

The external surface of the crura consists of white matter, which is about two lines thick, and presents a distinctly fibrous character: within this is inclosed a quantity of grey substance, so dark as to have received the name of *locus niger*. The arrangement of these structures can be readily seen by making a transverse section of the crus: the dark part is found to be convex inferiorly, and concave above, so that the section of it presents a lunated form. The optic nerves rest upon the external surface of the crura as they pass forwards to their commissure.

659. All the parts of the brain hitherto noticed can be examined without any division of its texture, as they are placed superficially, but several are inclosed within its interior which cannot be seen without dissection. Between the hemispheres, and extending transversely from one to the other, is placed the *corpus callosum* (*mesolobe; commissura magna cerebri*); its form is that of an elongated layer of medullary fibres, placed horizontally, but nearer to the anterior than to the posterior margin of the brain. Its extent from before backwards is about three inches, but its breadth from side to side cannot be assigned, as it becomes blended with the substance of the hemispheres. Its superior surface is convex in its general outline, and concealed by the hemispheres, which overlap it. When these are removed a superficial linear impression will be perceived exactly in the middle line, and at each side of it a slight longitudinal elevation. To this the term raphé, or suture, is applied, as it indicates the point at which the union of the hemispheres takes place when their development is being completed. The inferior surface of the corpus callosum forms the roof of the lateral ventricles on each side, and towards the middle line it rests on the fornix, with which it is blended posteriorly: in front it gives attachment to the septum lucidum. Its anterior extremity, which when viewed externally presents a rounded border, is prolonged downwards and backwards to the

base of the brain, where it forms a thin semi-transparent lamella. This reflected part is nearly horizontal in its direction, so that it lies beneath the corpora striata and above the commissure of the optic nerves, to which it adheres, but still passes backwards, and becomes continuous with the tuber cinereum in the middle line, and at each side its margins are blended with the substantia perforata. The posterior border of the corpus callosum, which is also thick and rounded at the middle line, divides into two fasciculi of fibres, which can be traced into the posterior and descending cornua of the ventricles; one of these forms the medullary investment of the hippocampus minor, the other that of the hippocampus major.

660. Beneath the corpus callosum are situated the lateral ventricles, occupying the interior of the hemispheres. Their shape is very irregular, and can scarcely be said to bear a resemblance to any known figure. Each of them may be considered as divisible into a body, or central portion, and three cornua. The central part lies horizontally: one cornu extends forwards from it into the anterior lobe, another backwards into the posterior, and the third downwards into the middle one; each of these presents certain peculiarities referrible to the parts seen within them, which deserve notice. In the central part will be observed the corpus striatum, thalamus nervi optici; and between them the tænia semicircularis, also the margin of the fornix, and part of the plexus choroïdes. Previously to describing these objects it may be observed that the lateral ventricles are separated by a partition (*septum lucidum*) which descends from the corpus callosum to its reflected lamella in front, and to the fornix behind. It consists of two thin lamellæ of white substance, between which is a fissure, or interval, called the *fifth ventricle*. Beneath the corpus callosum and septum lucidum is a triangular lamella of white matter, which is extended from behind forwards over the third ventricle, and is thence termed *fornix*. Its

upper surface gives attachment to part of the septum lucidum, and posteriorly becomes united with the corpus callosum; the inferior one overlays the third ventricle and the thalami nervorum opticorum, but is separated from them by the velum interpositum. Some oblique lines are traced on this surface, on which account it has been termed *lyra*, or *corpus psalloïdes*. The anterior extremity of the fornix is narrow, and divides into two fasciculi (*pillars of the fornix*), which curve downwards at the forepart of the third ventricle, immediately behind the anterior commissure, and terminate at the base of the brain by investing the corpora albicantia. The base of the fornix gives off at each angle a thin flat process, which passes into the descending cornu, and assumes the name of corpus fimbriatum. The *anterior cornu* of each ventricle inclines outwards, diverging from its fellow of the opposite side; the corpus striatum projects a little into its floor: the remainder of it resembles a groove in the cerebral substance. The *posterior cornu*, called the *digital cavity*, converges towards that of the opposite side, and presents in its floor the *hippocampus minor*. This is a slight elevation, composed of a lamella of white matter inclosing some cineritious substance; it gradually tapers to a point, and reaches to within an inch of the posterior extremity of the hemisphere. The *inferior* or *descending cornu* passes at first backwards and outwards from the body of the ventricle, but after descending a little, it changes its direction altogether, and proceeds forwards and inwards, to terminate at the base of the brain, within a few lines of the fissure of Sylvius. This is the largest of the cornua: its convexity looks outwards and backwards, its concavity in the opposite direction: the under surface of the thalamus forms its roof, and the plexus choroïdes rests loosely on its floor, concealing the hippocampus major and corpus fimbriatum.

661. The *hippocampus major* (*cornu ammonis*) resembles, in shape, a cerebral convolution; it is curved so

that its convex border looks outwards, and the concave inwards, conforming with the direction of the cavity in which it lies. Its anterior extremity expands somewhat, and presents two or three, and sometimes as many as five, small prominences, separated by slight depressions, which make it to resemble somewhat the back of the hand when close shut. Some of the older anatomists called it *pes hippocampi*, from its resemblance to the clubbed foot of some of the lower animals. At the point where the cornu makes its curve forwards, a slight elevation is sometimes observed, which is called *pes accessorius*. Along the inner border of the cornu is a narrow falciform process of white substance (*corpus fimbriatum*), which is adherent by one edge to the floor of the cornu. It gradually becomes narrow, and ends in a point a little behind the pes hippocampi. Near the inner border of the corpus fimbriatum, a narrow line of cineritious substance (*fascia dentata*) is placed; it is not perceptible until the middle lobe, together with the inferior cornu of the ventricle, is drawn outwards, as it is excluded from the cavity of the cornu by the reflection of the arachnoïd membrane; its free border is marked by several transverse notches, giving it a dentated appearance, from which its name is derived. The cornu ammonis consists externally of a lamella of white substance, which, if traced upwards into the body of the ventricle, will be found continuous with the corpus callosum. The corpus fimbriatum, in like manner, will be found continuous with the fornix.

662. The *corpora striata* (*ganglions cerebraux superieurs*, Gall,) are two in number, situated one in the body of each lateral ventricle. Each of these bodies is pyriform in its shape, the larger extremity being turned forwards and inwards, the smaller backwards and outwards. The superior surface is smooth and slightly prominent in the cavity, all the rest being embedded in the substance of the hemisphere. Their position is so oblique, that though

in front they are separated by not more than three or four lines, their posterior extremities are from an inch and a half to two inches apart, the interval being occupied by the optic thalami, and the third ventricle. Their external surface is composed of grey substance, but internally the grey and white are intermingled, so as to produce a striated appearance, whence the name is derived.

663. The *optic thalami* (*thalami nervorum opticorum, ganglions cerebraux posterieurs,* Gall,) are placed behind and between the preceding. The upper surface of each projects into the body of the corresponding ventricle; the inferior one forms the roof of its descending cornu, and the external is blended with the corpus striatum and the substance of the hemisphere. The internal surface of each thalamus contiguous to that of the opposite side, is partially united to it by a soft lamella of grey substance, (*commissura mollis*). On the posterior border of each thalamus are observed two slightly-raised papillæ (*corpus geniculatum internum et externum*), which are connected by medullary striæ to the tubercula quadrigemina, the external one being also united to the origin of the optic nerve. The contiguous borders of the optic thalamus and corpus striatum are separated by a thin fasciculus of nervous matter of a pale straw colour (*tænia semicircularis*); it extends from before backwards, commencing near the anterior pillar of the fornix, and ending at the corpus geniculatum externum. Along the inner margins of the thalami two delicate white fasciculi arise, and pass backwards, converging to the pineal gland, whose peduncles they form, and at the same time constitute its only bond of connexion with the substance of the brain. The *pineal gland* is a small mass of grey substance of a conical shape, and is sometimes called *conarium,* from its resemblance to a fir-cone. Its base rests on the tubercula quadrigemina; it usually contains in its interior some sabulous matter.

664. The optic thalami inclose between them a narrow

cavity (*third ventricle*), which corresponds exactly with the middle line, and resembles a longitudinal fissure. Its sides are formed by the thalami, its floor by the locus perforatus and tuber cinereum; the velum interpositum and formix cover it in. The anterior commissure, and the pillars of the fornix, bound it in front. Into this cavity leads an aperture (*foramen commune anterius*; *foramen Monroi*), which is a rima between the anterior pillars of the fornix and the thalami, and which establishes a communication between the third and the lateral ventricles; a foramen leads out of it downwards and forwards, (*iter ad infundibulum*). It may be observed that the infundibulum becomes imperforate at its middle, which appears to be owing to a small cul-de-sac of arachnoïd membrane, which is prolonged into it. From the posterior extremity of the ventricle another foramen opens into a canal (*iter a tertio ad quartum ventriculum; aquæductus Sylvii*), which leads obliquely downwards and backwards into the fourth ventricle. Two cord-like fasciculi are stretched across the extremities of the third ventricles, and prolonged into the hemispheres which they connect, serving as commissures. The *anterior commissure* lies just before the pillars of the fornix, and as it extends laterally it will be found embedded in the substance of the corpora striata on each side, but does not become blended with them; its extremities arch backwards a considerable way, so as to form a curve, whose convexity looks forwards. The *posterior commissure* is much shorter than the preceding, and extends but a few lines on each side into the thalami: it lies above the aqueduct of Sylvius, and before the tubercula quadrigemina.

The Cerebellum.

665. The second division of the central mass of the nervous system is the cerebellum, which differs in situation and size, as well as in the arrangement of its component

parts, from the cerebrum. It is lodged in the recess formed between the tentorium cerebelli and the inferior occipital fossæ, its size, as compared with that of the brain, being as 1:8. Its surface, instead of convolutions, is divided into a number of concentric lamellæ, placed perpendicularly on their edges, and inclosed one within the other. If the sulci between them be opened, several other lamellæ will be found inclosed within them, but smaller and more irregular. The cerebellum is divided into two lateral lobes, the division being established behind by a fissure, which receives the falx cerebelli, and in front by a deep excavation, which lodges the medulla oblongata. The *superior surface is* slightly depressed on each side, where the tentorium rests upon it, but along the middle line a rounded ridge (*processus vermiformis superior*) runs from before backwards, and seems as if produced by the rippling up, or admixture of the folia of the lobes, as they extend from without inwards. There appear to be from sixty to seventy folia on the upper surface of the cerebellum, which are aggregated into five fasciculi. The *inferior surface* is convex, and dips down into the occipital fossæ; along the middle line runs the *inferior vermiform process,* interposed between the lateral lobes; it resembles a lobule formed of short transverse folia; its anterior extremity has been compared to a mammillary process. The mass of medullary matter enclosed within the cerebellum is connected with three pairs of medullary fasciculi. From the interior of the lobes two fasciculi (*processus e cerebello ad testes*) pass forwards and upwards to the lower pair of the tubercula quadrigemina; they converge in their ascent, and are connected by a semitransparent medullary lamella (*valvula Vieusseni*). The valve presents on its upper surface a slight groove, running from above downwards, and sometimes a linear ridge, like a raphé; it overhangs the fourth ventricle. Two processes pass obliquely upwards and outwards from the medulla oblongata into the cerebellum, (*corpora restiformia, pyramides posterieures*). The largest of the fasciculi here referred to are the *crura cerebelli*, which are concealed within the lobes, and even when about to emerge from their substance they are overlapped by some minor lobules. They incline forwards and inwards, descending somewhat, and become continuous with the fibres of the pons Varolii, which are thus derived from the crura cerebelli. The pons, from its mode of formation, bears the same relation to the cerebellum that the corpus callosum does to the cerebrum, as it is composed of converging fibres, and may therefore be called a commissure.

666. The cerebellum incloses a cavity called the *fourth ventricle*, the roof of which is formed by the valve of Vieussens, and processus ad testes, the sides by the lobes of the cerebellum; the dorsal surface of the medulla oblongata forms its floor, and it is completed inferiorly by a reflection of the arachnoïd membrane: a process of pia mater projects into it at this situation, called *choroides minor*. If a vertical section be made of one of the lobes of the cerebellum, in such a way as that two-thirds of its breadth shall lie external to the incision, an oval nucleus of grey substance (*corpus dentatum*, vel *rhomboideum*) will be exposed; its texture is usually firm, and its border notched, so as to give it a dentated appearance. Gall considers it as a ganglion of increase to the formative fibres of the cerebellum. The surface of the section here indicated presents rather a peculiar appearance: the white substance will be found so disposed as to represent the stalk and branches of a tree, hence called (*arbor vitæ*.) The branches project into the folia of the cerebellum, and the grey substance invests them so as to resemble pennatifid leaves. If a horizontal section be made, so as to divide the lobe into two equal parts, the quantity of white substance will appear considerably greater than that of the grey.

The Cerebral Protuberance.

667. The *cerebral protuberance* is much the smallest portion of the central mass; its relative size being to that of the rest as 1 : 60. It is placed between the cerebrum, cerebellum, and medulla oblongata, having intimate relations with each by continuity of substance; hence it has been termed *nodus encephali*. It is a square mass, its depth being about equal to its length. Its anterior surface is convex, and rests against the basilar process of the occipital bone, and is composed of the converging fibres of the cerebellum, disposed so as to form a portion of a ring, which incloses the contiguous extremities of the crura cerebri and medulla oblongata, on which account it has been termed *protuberantia annularis*, or *pons Varolii*. Its upper border is bounded by a transverse line, marking its separation from the crura cerebri, and the lower by another line, which divides it from the medulla oblongata; along its middle is a shallow groove running from above downwards, which corresponds with the basilar artery. The posterior surface is almost entirely concealed by the cerebellum; it is surmounted by four rounded bodies (*tubercula quadrigemina*), disposed in pairs, one above the other, and separated by two decussating lines. The upper pair are the larger, and called *nates*—the lower, *testes:* they are connected in front with the thalami, inferiorly with the processus ad testes, and the valve of Vieussens, and between their upper surface and the corpus collosum is a rima or fissure (*fissure of Bichât*), through which the arachnoïd membrane enters to line the ventricles.

The irregular vacuities disposed in the interior of the cerebellum and brain communicate freely with one another by certain constricted portions, or foramina. If, whilst the brain and cerebellum remain "in situ," the latter be divided by a vertical incision made from the valve of Vieusseus downwards through its substance, the fourth ventricle will be exposed. This cavity contracts towards its upper part into a tube (aqueduct of Silvius), which is directed upwards and forwards, under the corpora quadrigemina and the posterior commissure, into the middle or third ventricle. The latter again communicates at each side with the lateral ventricles by a rima *(foramen Monroi)*, situated between the pillars of the fornix and the thalami, on which they rest. When the ventricles have been distended with fluid this rima assumes a rounded form, and then only represents a foramen. These vacuities, then, should be considered not as so many separate cavities, but as a series of compartments of one cavity contained within the cerebral mass, and this is the appearance they present during the earlier periods of fœtal life. The cavity, however, is not a shut sack, for the membrane which lines it is continuous with that which invests the external surface of the brain and cerebellum. It has been already stated, that the arachnoïd membrane passes in through the fissure of Bichât. Two other fissures are situated on either side between the corpora fimbriata and the crura cerebri, through which the pia mater enters, to form the plexus choroides. These may be considered as chinks between the portions of cerebral substance just referred to; but they are closed up by the manner in which the arachnoïd membrane is reflected from the sides of the cornua of the ventricles upon the plexus choroides.

The cerebral hemispheres are considered by Gall as resulting from an expansion or evolution of the fibres of the medulla; hence these are termed primitive, or formative fasciculi. The fibres of the anterior pyramids may be traced upwards to the margin of the pons, where they become somewhat constricted. From the inner border of each, fibres pass across the middle sulcus, and mutually change place, or decussate, those of the right side passing to the left, and "vice versâ." If an incision, a line or two in depth, be made through the pons, so that one lateral half of it may be turned outwards, the fibres of the pyramid will be observed to pass into a quantity of grey substance lodged in the interior of the nodus encephali. In this situation the fibres diverge and separate, and are also considerably increased: at the upper margin of the pons they become continuous with the crus cerebri. Here an additional increase is derived from their passage through the grey substance lodged in the interior of the crus, after which they proceed through the inferior cerebral ganglion (*thalamus nervi optici*), and in the next place through the superior one (*corpus striatum*), being successively increased and rendered still more divergent until finally they reach the anterior and middle lobes, where they are evolved into their inferior, external, and anterior convolutions. The corpus olivare contains within itself a small ganglion; its fibres pass, without any decussation, into the grey substance lodged in the cerebral protuberance, where, like the pyramids, they receive additions, after which they pass into the crus cerebri, of which they form the posterior and inner part. Continuing their ascent, after being increased in the locus niger, they pass through the optic thalamus, and thence into the corpus striatum, receiving additions as they radiate through each, and, finally, are continued upwards into the convolutions at the summit of the hemisphere, and backwards into those of the posterior lobe. Previously to entering the optic thalamus some fibres of the corpus olivare have been observed to turn inwards, so as to give to the tubercula quadrigemina their medullary investment, and also to unite with those of the opposite side, to form the valve of Vieussens. The diverging fibres thus traced up through their successive steps of increase, terminate in the grey substance of the convolutions: but another order of fibres may be observed quite distinct from these, and taking a different direction. These are called the *converging fibres*, as they commence at the peripheral terminations of the preceding set, and pass from without inwards to the middle line, so as to connect the lateral parts, and bring them into relation with one another; on which account they are called commissures. The anterior and posterior commissures are formed in this way, as is also the corpus callosum; though the greater number of the fibres which compose the latter are transverse, those towards its extremities are oblique. This is owing to the manner in which the converging fibres of the anterior lobe are constrained to pass from before backwards, and those of the posterior lobe from behind forwards, in order to gain the corresponding borders of the corpus callosum. By this arrangement a greater number of fibres are collected to its extremities, which renders them thicker (particularly the posterior one) than any other part of its extent. Some of the inferior fibres thus traced from without inwards, instead of uniting with the corresponding set along the middle line, become reflected downwards from the under surface of the corpus callosum to the fornix, and so form the septum lucidum. The convolutions of the posterior lobe are brought into relation with those of the middle one by means of the fornix, the fibres of which are stretched from behind forwards in such a way, that whilst its body is in a manner unattached, the extremities are identified with the parts just referred to.

The formative fibres of the cerebellum are derived from the posterior pyramids, or corpora restiformia: they pass upwards and outwards, and soon meet the corpus rhomboideum, which is considered as the ganglion of the cerebellum: the fibres are supposed to proceed through the grey substance of which it is composed, though it is difficult to demonstrate the fact; after which they pass outwards, diverging into the lobes of the cerebellum. The converging fibres, by their union, form the crura cerebelli, and the fibres of each crus, expanding as they pass downwards and inwards, constitute by their junction the pons Varolii, which brings the lateral lobes of the cerebellum into relation, and forms their commissure. The processus a cerebello ad testes bring the lobes of the cerebellum into intimate connexion with the cerebral hemispheres.

The Cerebral Arteries.

668. The brain is supplied with blood by the vertebral and carotid arteries; and the residual blood is received by veins, which run apart altogether from the arterial branches; those within the skull pour their contents into sinuses formed in the dura mater; but those in the spine form a system by themselves, marked by several peculiarities.

669. 1. The *vertebral artery* is a principal branch of the subclavian. It enters the foramen in the fifth or sixth cervical vertebra, and ascends vertically along the canal formed by the chain of foramina in the transverse pro-

cesses, as far as the axis, at which point it inclines outwards, in consequence of the greater width of the atlas. Having passed through the latter, it winds backwards round its articulating process, lying in a shallow groove behind it; and having pierced the dura mater, enters the skull through the foramen magnum. The vessel finally passes forwards, converging to that of the opposite side, and unites with it, their conflux forming the basilar artery. The latter is so named, from its lying on the basilar process of the occipital bone: its length corresponds very nearly with the breadth of the pons Varolii, with which it is in close contact, and at whose anterior border it divides into four branches, two for each side. The vertebral artery in its ascent is accompanied by a vein of the same name, which commences by branches at the base of the skull, and comes into contact with the artery at the first vertebra. Both vessels lie anterior to the series of cervical nerves, which they cross at right angles. The branches of the vertebral artery in the neck are merely some small twigs to the dura mater of the spine, and some to the deep-seated cervical muscles: those within the skull are,

a. Arteria meningea posterior, which is a small branch that arises when the artery is opposite the foramen magnum, and ramifies upon the dura mater.

b. ——— *inferior cerebelli* arises at the side of the medulla oblongata, and turns backwards and outwards beneath the lateral lobe of the cerebellum, to which it distributes numerous ramifications, some of which extend to the inferior vermiform process, and to the fourth ventricle, through the medium of its choroïd plexus.

c. ——— *spinalis posterior* inclines backwards round the medulla oblongata, to reach the posterior surface of the medulla spinalis, along which it descends parallel with its fellow of the opposite side, as far as the second lumbar vertebra, where it terminates in ramifications on the cauda equina. Both these vessels are long and tortuous, and maintain frequent communications by transverse branches.

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scends it inclines to its outer side, and finally passes in front of it as well as of the external carotid artery. The artery is supported by the rectus anticus muscle, and is crossed by the digastricus and stylo-hyoideus muscles, and the lingual nerve. Higher up, the stylo-pharyngeus and stylo-glossus, together with the glosso-pharyngeal nerve, pass also in front of it, interposed between it and the external carotid artery. On reaching the lower margin of the canal, appropriated to it in the pars petrosa of the temporal bone, the internal carotid artery ascends perpendicularly a little way, and then inclines forwards and inwards, its direction being influenced by that of the osseous tube which lodges it. It soon, however, ascends somewhat to reach the posterior clinoïd process, close by which it pierces the deep lamella of the dura mater, which forms the cavernous sinus, but does not enter the cavity of the latter, as it becomes invested by a reflection of its lining membrane. The artery, in the next place, passes horizontally forwards to the base of the anterior clinoïd process, where it curves upwards, and pierces the superficial or cerebral lamella of the cavernous sinus: finally, becoming invested by the arachnoïd membrane, it reaches the fissure of Silvius, in which it divides into its terminal branches. Whilst in the canal, the artery is inclosed in a plexus formed by the sympathetic nerves, and gives off a small branch, which enters the tympanum and anastomoses with the stylo-mastoïd branch of the internal maxillary. Whilst in the sinus a small twig is sent to the dura mater (*meningea anterior*). The ophthalmic artery is given off close by the anterior clinoïd process: this shall be described with the parts contained within the orbit. After having pierced the inner lamella of the dura mater, the internal carotid artery gives off the following branches:—

a. Arteria communicans posterior runs directly backwards, parallel with its fellow of the opposite side, so that they inclose *d.* ——— *spinalis anterior*, smaller than the preceding, descends in front of the medulla oblongata, and unites with the corresponding branch of the opposite side, immediately below the foramen magnum, so as to form one long vessel, which descends in the middle line in front of the medulla spinalis, at the extremity of which it passes through the nervous filaments, forming the cauda equina, and terminates at the lower part of the canal in delicate ramifications. It gives numerous branches to the spinal cord and its nerves, and communicates with the branches which enter through the intervertebral foramina.

670. The branches of the basilar artery are the following:—

a. Several ramusculi are given to the cerebral protuberance and adjacent nerves: one also accompanies the seventh pair of nerves in the labyrinth of the ear.

b. Arteria cerebelli superior turns backwards and outwards round the upper margin of the pons Varolii, to reach the superior surface of the cerebellum, upon which it ramifies freely.

c. ——— *profunda cerebri* is larger than the preceding, and separated from it by the third nerve: it turns round the crus cerebri, and inclines backwards to the posterior lobe of the cerebrum, along which it distributes numerous branches, for the supply of its substance. At the point where this vessel turns backwards, it receives the communicating artery from the internal carotid, and so contributes to form the circle of Willis.

671. 2. The *internal carotid artery* having commenced at the division of the common carotid (Sect. 518), opposite the upper border of the thyroïd cartilage, inclines at first somewhat backwards and outwards, but soon turns forwards and inwards, and ascends to the base of the skull, to reach the carotid foramen. In this course the artery is accompanied by the internal jugular vein, which lies external to it, and by the vagus and sympathetic nerves, to which it is closely united by cellular tissue. The hypoglossal nerve at first lies behind the artery; but as it de-

The Membranes of the Brain and Medulla Spinalis.

672. The brain and medulla spinalis are invested by three membranous lamellæ, namely, the dura mater, the arachnoïd membrane, and the pia mater. The *dura mater*, which is the most external of the three, is thick, firm, and resisting, and belongs to the class of fibrous, or rather fibro-serous membranes, as it is in reality a compound structure; the outer lamella being fibrous, the inner serous, and derived from the arachnoïd membrane. It is in close apposition with the cranium, which it lines, at the same time that it invests the brain, and sends inwards processes which are interposed between its different parts, serving to sustain them. It is, moreover, prolonged in a tubular form through the spinal canal, but is separated from the bones by a lamella of adipose tissue, and the rachidian veins. It adheres to the arch of the skull, particularly along the sutures, but at its base the points of connexion are multiplied by its passing over the inequalities of the surface, and still more so by sending tubular prolongations through the different foramina, serving to inclose and protect the nerves which they transmit. Along the spinal column similar prolongations pass out with the nerves through the inter-vertebral foramina: these constitute its chief connexion with the bones. But towards the lower part of the sacral canal it is fixed by some irregular fibrous bands. The processes formed by the dura mater are the following:—

a. The *falx cerebri* is lodged in the longitudinal fissure between the hemispheres, forming a partition between them. It is narrow before, broad behind, and presents a curved border inferiorly, so that in shape it resembles a sickle; whence its name. It extends from the crista galli, which is inserted between its lamellæ, to the internal occipital protuberance, on a level with which it becomes blended with the tentorium cerebelli. It seems as if formed within them the infundibulum, with the corpora mammillaria, and both terminate in the profunda cerebri arteries; thus forming the sides of the circle of Willis.

b. ——— *cerebri anterior* arises from the division of the internal carotid, opposite the inner termination of the fissure of Silvius. From this point it inclines forwards and inwards to reach the margin of the longitudinal fissure, in which it is connected with its fellow of the opposite side by a branch not more than two lines in length (*communicans anterior*). The two arteries in the next place, lying close together, turn around the anterior border of the corpus callosum, and on reaching its upper surface, run from before backwards upon it, overlapped by the cerebral hemispheres. In this course numerous branches are given off to the cerebral convolutions.

c. ——— *media cerebri* inclines obliquely outwards, taking the course of the fissure of Silvius, within which it divides into several branches, for the supply of the anterior and middle lobes of the brain. Some of these branches, as they ramify in the pia mater, turn forwards to the substantia perforata antica; and one or two will also be observed to enter the fissure between the middle lobe and the crus cerebri, to reach the descending cornu of the ventricle, where they are distributed to the plexus choroïdes (*arteria choroïdeæ.*)

A remarkable inosculation exists between the branches of the vertebral and carotid arteries, by which the circulation in the brain is equalized, and any deficiency that may arise from the obliteration of one, or even two of the vessels, is speedily supplied by the others. This inosculation, which is known as the circle of Willis, results from a direct communication between the following branches. The anterior cerebral arteries, as they converge, are connected by their anterior communicating branch. These, or rather the trunk from which they arise, are united by the reflected communicating branches with the profunda cerebri arteries, and the two latter are united with the basilar artery at its point of termination. Within the area thus included will be observed the commissure of the optic nerves, the infundibulum and tuber cinereum, the corpora mammillaria, and the origins of the third pair of nerves.

at their conflux:—*a.* The *superior longitudinal sinus,* commencing at the crista galli, extends from before backwards, in the upper border of the falx, gradually increasing in size as it proceeds. Across its cavity, which is triangular, several bands (*chordæ Willisii*) extend obliquely. The veins from the cerebral surface open into this sinus in such a way that the apertures of the greater number of them are directed from behind forwards, contrary to the direction of the current within it, so that though regurgitation may take place into the sinus, it does not follow that it shall extend into the brain, as the blood in the sinus, by its pressure, will close the mouths of the veins, by reason of their valvular structure. *b.* The *inferior longitudinal sinus* is very small; it runs in the concave border of the falx, and terminates in the straight sinus. *c.* The *straight sinus* lies in the base of the falx, and runs directly backwards to the conflux: in addition to the preceding, it receives the *venæ Galeni,* which return the blood from the lateral ventricles. *d.* The *occipital sinuses* are two small canals extended from the foramen magnum to the conflux inclosed in the falx cerebelli. *e.* The *lateral sinuses,* two in number, curve downwards and forwards along the occipital grooves, corresponding with the external border of the tentorium cerebelli. Commencing at the conflux where they receive the blood from the other sinuses, they convey it to the jugular fossæ, where they transmit it to the jugular veins.

The following sinuses lie in the base of the skull:—*a.* The two *cavernous sinuses* are placed one at each side of the sella Turcica, between the anterior clinoïd process and the margin of the pars petrosa. The dura mater in this situation is divided into two lamellæ, the one being deeply seated and in close apposition with the bone, and the other stretched between the bony processes just mentioned, the irregular interval between them forming the sinus: into this opens the ophthalmic vein from before, and the circular sinus on its inner side open: along its outer wall are placed the nerves which proceed to the orbit, and at its inside the carotid artery, invested by a reflection of its lining membrane. *b.* The *circular sinus* surrounds the pituitary gland, and opens into the cavernous sinuses at each side. *c.* The *superior petrous sinuses,* commencing on each side at the summit of the pars petrosa, where they in the following manner:—The fibres of the dura mater, on approaching the sagittal suture from each side, divide into two lamellæ, one of which is continued uninterruptedly across, so as to maintain the continuity of the membrane, but the other dips down, converging to that of the opposite side, so that they inclose between them an angular interval, viz. the longitudinal sinus. After their union they continue to descend to the margin of the falx, where they separate, and unite again, so as to form the inferior longitudinal sinus. A section of the upper sinus is found to be triangular, of the lower circular. On the surface of the dura mater, and in close contact with the arch of the skull, several small granular bodies exist, called *glandulæ Pacchioni.*

b. The *tentorium cerebelli* spreads out from the base of the falx, and serves to support the posterior lobes of the brain: one border of it is attached all around to the lateral grooves on the occipital bone, and to the margin of the pars petrosa; the other, concave and free, bounds with the posterior clinoïd processes, an oval interval, which transmits the crura cerebri, processus ad testes, and basilar artery. *c.* The *falx cerebelli* is a narrow fold placed between the lobes of the cerebellum, extending vertically from the under surface of the tentorium to the foramen magnum; its base lodges the occipital sinuses.

The vascular system of the brain and spinal cord present several peculiarities. The arteries run separately from the veins, and their branches ramify minutely in the pia mater before they enter the cerebral substance. The small veins for the most part lie in the sulci, between the convolutions, and run with different degrees of obliquity to the sinuses, which are so many reservoirs formed in the substance of the dura mater. The form of the sinuses is irregular: they are lined by a continuation of the internal membrane of the jugular veins, which is prolonged into the sinuses, though their fibrous coat ceases at the jugular fossæ. The sinuses which are formed in the processes of the dura mater converge to a common point, which corresponds with the internal occipital protuberance, and is called the *conflux of the sinuses,* or *torcular Herophili*: its form is very irregular: if a square piece of bone be removed, and the dura mater laid open at the point above referred to, the apertures of the following sinuses will be observed constricted at both extremities, which communicate by short narrow canals with the veins at the forepart of the spine. In the thoracic region they open into the azygos and intercostal veins, in the loins into the lumbar veins, in the neck for the most part into the vertebral.

A complex interlacement of tortuous veins is established along the inner surface of the arches of the vertebræ. In the lower part of the canal the interlacement is not so close as in the upper portion, where it usually conceals (if the injection has run minutely) the whole surface of the dura mater. These veins also converge to the inter-vertebral foramina, and open by rather narrow channels into the intercostal veins. The numerous foramina observable in the bodies of the vertebræ give exit to veins *(veines basi-vertebrales)* which open into the great spinal veins. Another group of veins *(veines dorsi-spinales,* Breschet*)* arise amongst the extensor muscles, and pass in a tortuous course forwards, to reach the spaces between the arches of the vertebræ, and open into the mesh of the spinal veins, after having pierced the ligamenta sub-flava. Some of these, however, accompany the posterior branches of the lumbar and intercostal arteries, and with them pass through the spaces between the transverse processes of the vertebræ, to open into the lumbar or intercostal veins. These veins literally encircle the roots of the transverse processes. The veins that issue from the medulla spinalis can seldom be injected so as to shew their distribution accurately. They are small and tortuous, and form a mesh, by frequent unions and separations on both surfaces of the medulla. From this net-work small veins issue, and accompany the nerves in their course to the intervertebral foramina, where they appear to terminate in the great spinal veins.

In other parts of the venous system the blood flows in vessels, forming continuous tubes, which diminish in number as they increase in size in their progress towards the heart, each tributary current joining, in most instances, at an acute angle with the larger one into which it flows. But here the blood from the muscles, and from the interior of the spine, is conveyed into the great spinal veins, which are wider in the middle than at their extremities, and therefore resemble so many reservoirs, from which it flows off by outlets, or minor veins, terminating in the general venous system. What is the propelling power of the blood in these veins? Muscular action can have no influence; and if it depended on the "vis a tergo" solely, congestion and extravasation would be not unlikely to occur frequently, in consequence of the many sources of retardation observable in the whole series. M. Breschet[*] conceives, that the circulation in the great rachidian veins presents several points of similitude with that in some of the animals that occupy the lower grades in the scale of being, and that it is performed with a degree of slowness proportioned to the impediments to its course. It may not be amiss to subjoin M. Breschet's method of injecting and preparing these veins. In the first place it is necessary to select an old subject, as the venous system is always more developed in old age; and the thinner the body is, the better. It should be heated thoroughly by being steeped in water. Injecting pipes should be inserted into the superior vena cava and vena azygos, also into the inferior cava; one may also be passed into the gluteal vein, and another into the superior longitudinal sinus. A size injection, coloured blue, or one of isinglass, should be forced, as nearly as possible, simultaneously through these different tubes. If the injection succeeds, a vertical section of the head and spine will be necessary, in order to expose the great spinal veins.

674. The *pia mater*, in its anatomical characters, differs considerably from the other membranes. It is made up of a thin lamella of cellular tissue, permeated by a multitude of minute capillary arteries, which ramify in it previously to their entrance into the cerebral substance. It invests the medulla spinalis, as well as the brain, and dips into the sulci between the convolutions of the latter: we also find it prolonged into the anterior of the ventricles, assuming the name of *plexus choroides*. Its inner surface is in close contact with the cerebral substance; the external is in apposition with the arachnoid membrane on the surface of the convolutions, but loses all connexion with it after passing into the sulci. In the fissure observable on the base

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[*] *Essai sur les veines du rachis.*

of the brain, between the inner margin of the middle lobe and the crus cerebri, the pia mater enters the inferior cornu of the ventricle, where it corresponds at first with the interstice between the corpus fimbriatum and crus cerebri, and afterwards lies along the floor of the ventricle, in which it ascends upon the thalamus nervi optici, and unites at the foramen or fissure of Monro with the plexus of the other side. At its entrance into the ventricle the plexus is drawn together so as to resemble a small vascular bundle, and becomes invested by the arachnoïd membrane, which, by its reflection from the sides of the ventricles to the plexus, maintains the integrity of the cavity. Where the pia mater is prolonged on the medulla oblongata, it forms a small plexus, which enters into the fourth ventricle, and becomes also invested by a duplicature of the arachnoïd. As the membrane descends into the spinal canal it becomes firm, resistant, and much paler in colour. Its inner surface is in close contact with the medulla, the exterior is but slightly connected to the arachnoïd, and the nerves, at the different points at which they pass outwards, derive from it their immediate investment, or neurilema. The difference of character here pointed out between the spinal and cerebral parts of the pia mater, appears to M. M. Jules and Hippolite Cloquet sufficient to induce them to consider it as a distinct structure. But it would be difficult to shew where the continuity of the membrane is interrupted; and as to any difference of character and consistence that may appear, they are merely such as may be supposed to arise from the different circumstances in which the membrane is placed. In the spine it is exposed, in a considerable degree, to the influence of motion and pressure, which necessarily produce the same effect on it as on cellular textures elsewhere; that is to say, they render it thick and lamellar. Again, superiorly it is in contact with grey substance, in the spine with white, so that we can readily account for the difference of the vascularity in the membrane, by recurring to the relative vascularity of the structures with which it is in contact.

675. The serous investment of the brain and medulla spinalis is called the *arachnoïd membrane,* from its tenuity. It is smooth and transparent, and, like all the other membranes to which it belongs, forms a shut sack: one part of it invests the brain and medulla, passing over the surface without dipping into the convolutions; the other lines the dura mater and its different processes, with which it is inseparably connected. Moreover, as the nerves and vessels pass across the intervals between their points of attachment to the cerebral substance, and those by which they escape from the cavity of the cranium, they are inclosed in tubular prolongations of the arachnoïd membrane, which are continuous by one extremity with the portion investing the brain and medulla, and by the other with that which lines the dura mater. By this arrangement the continuity of the membrane is maintained, at the same time that the apertures of transmission are closed. The arachnoïd membrane is prolonged into the ventricles, lining them in their entire extent, and forming within them a remarkable duplicature (*velum interpositum*). By these means its arrangement is rendered as complex as that of the peritonæum; and were we, with the same view, and on the same principle, to trace its reflections, they would be found as follows:—

We shall suppose, in the first place, a vertical section of the skull and the spine to be made, so as to lay open their cavities. Commencing then at the vertex, we trace the membrane along the upper and under surface of the anterior lobe of the brain, and thence downwards upon the crus cerebri and pons. We then follow it on the anterior surface of the medulla spinalis down to the extremity of the cauda equina, where it is reflected upon the different nerves to the contiguous surface of the dura mater, and this it lines as far as the foramen magnum. From the foramen the membrane continues its adhesion to the dura mater, where it corresponds with the base and roof of the skull, and thence backwards to the occipital protuberance. At the latter point it is reflected over the tentorium, coating both its surfaces, and is thence prolonged down through the foramen magnum, still bearing the same relation to the fibrous membrane, as far as the extremity of the canal. At this point it is reflected forwards upon the medulla, which it invests in its entire extent. From the medulla oblongata, it is, as it were, guided by the corpora restiformia to the cerebellum, and having invested both its surfaces, reaches the processus ad testes, on which it is continued to the under surface of the cerebral hemisphere, and is thence prolonged to the vertex, that is to say, to the point from which we set out. When the continuity of surface is thus shewn at each side, the lateral parts of the membrane will be found continuous, by tracing them over the flat surfaces of the hemispheres, and down to the corpus callosum, so that if a transverse section were made of the cerebral hemispheres, the part of the membrane which is reflected from their flat surfaces over the corpus callosum, will represent a cul-de-sac. Now if we trace the membrane along the posterior border of the corpus callosum, it will be found to turn beneath it, and to enter the ventricle through the fissure of Bichât. Again, the part of it which lies on the tubercula quadrigemina is also prolonged into the ventricles, lying, like the preceding, close on the cerebral substance, and constituting an investment for it. If the falx and tentorium have been left undisturbed, by drawing aside the posterior cerebral lobes, a tubular process of arachnoïd membrane will be observed passing out of the fissure, and directed backwards to the point at which the border of the falx joins with that of the tentorium. This process is prolonged from the velum interpositum, and incloses the venæ Galeni, which are two small veins that return the blood from the plexus choroïdes, and pass from before backwards, inclosed within the velum, to terminate in the straight sinus. We have then within the ventricles to examine a prolongation of the membrane which lines their surface, and another, which is in a manner free and unattached (*velum interpositum*), each being continuous with the other, and both with the more extended serous surface already examined. That the membrane lines the roof of the ventricles may be proved by cautiously dividing the fibres of the corpus callosum, and pushing them aside. A thin membranous lamella will be thus exposed, which, though diaphanous, is sufficiently firm to confine air or fluid passed into the ventricle. There are then two entering layers, one along the roof, the other on the floor of the ventricle, and a returning or tubular process continued back from these, and terminating as above stated. Their arrangement appears to be as follows: the arachnoïd membrane, after investing the surface of the corpus callosum as far as its posterior border, turns beneath it, passing through the foramen of Bichât. After lining the under surface of the fornix, it is reflected over its borders to the septum lucidum, upon which it is prolonged to the roof of the ventricles, and so to their outer margins. In this way it may be traced into the posterior and descending cornua as far as the points at which the plexus choroïdes of each side enters, on the upper surface of which it is reflected, to form the commencement of the velum interpositum. Now the part of the membrane that covers the tubercula quadrigemina, on reaching the interior of the ventricle, sends in the middle line a process into the third ventricle, and moreover gives off a cul-de-sac, which is prolonged into the fourth, lining its walls and closing its cavity inferiorly. On each side the membrane extends along the floor of the ventricles to their outer margins, where it is continuous with the part already traced to these points. It is similarly disposed of in the floor of the posterior and descending cornua, and on reaching the fissures which admit the plexus choroides at each side, it is reflected on the under surface of the latter; the part that lined the roof having been reflected on their upper surface, so that they are inclosed between two lamellæ of the serous membrane, in their entire extent, from the lateral fissures to the foramen Monroi. These lamellæ, from being stretched from side to side, between the fornix and third ventricle, constitute what is called *velum interpositum:* posteriorly, the velum is narrowed to a funnel-shaped process, which makes its exit through the fissure of Bichât, and on reaching the point at which the falx spreads into the tentorium, becomes continuous with the part of the membrane which lines those processes.

676. The *ligamentum dentatum* forms a connexion between the medulla spinalis and the contiguous surface of its fibrous investment. It is attached to the latter by a series of pointed processes, which give it a serrated or dentated appearance. The first process is fixed to the margin of the foramen magnum, between the vertebral artery and the hypoglossal nerve, and each succeeding one is implanted between the points at which the nerves make their exit. The bases of the processes form a continuous line along the side of the medulla, to which they are connected through the medium of the pia mater which invests it, and each of them resembles a delicate septum, interposed between the anterior and posterior roots of the nerves. It appears to be fibro-cellular in its structure, and quite distinct from the other membranes, particularly from the arachnoïd, which invests it.

SECTION II.

THE CEREBRAL NERVES.

677. THE *first pair of nerves (olfactory; par primum)* lies in a longitudinal groove marked on the under surface of the anterior lobe of the brain, about half an inch exterior to the median fissure; when undisturbed it appears flat, but is evidently triangular in form, the upper angle being lodged in the groove just alluded to. The nerve is soft in its texture, not being invested by a membranous tube or neurilema, but the arachnoïd membrane is stretched across its inferior surface, and so retains it "in situ." The nerve arises by three roots, two of which are medullary, the third or intermediate one being cineritious. The external root is the longest, and may be traced in the form of a white line obliquely outwards along the border of the fissure of Sylvius, where it corresponds with the last convolution of the anterior lobe of the brain: it appears to be

derived from the under surface of the corpus striatum. The internal root, shorter and broader than the preceding, arises at the inner termination of the fissure of Sylvius, from the substantia perforata. By turning down the nerve from the groove in which it is lodged, we see the third or cineritious origin, which comes from a papilla at the posterior extremity of the sulcus, or groove, just referred to. The first and second roots converge to the third, and the nerve thus formed passes forwards by the side of the crista galli, where it expands into an elongated bulb (*bulbus olfactorius.*) From the under surface of this structure numerous filaments descend through the cribriform lamella, each of which is invested by a tubular prolongation of the dura mater, and also by one from the arachnoïd, which latter, after descending a little way, reascends, and becomes continuous with the serous lining of the dura mater. The filaments of the olfactory nerve are arranged into three sets—the internal set are lodged for a while in grooves upon the surface of the septum narium, but soon ramify in the pituitary membrane—the external set descend upon the two superior turbinated bones, but the middle ones are short, and confined to the roof of the nares.

678. The *second pair* (*optic, nervus opticus, par secundum*) presents several striking peculiarities. They are the largest of the cerebral nerves, the fifth probably excepted; they are united by a commissure, but give off no branches, and their length within the skull is greater than that exterior to it. Each optic nerve arises not from the optic thalamus, but from the corpus geniculatum externum, and from a white fasciculus sent downwards from the nates. The nerve, at first soft and flat, rests on the crus cerebri, and passes forwards, converging to its fellow of the opposite side, with which it unites before the pituitary fossa, and between the anterior clinoïd processes. From the commissure each of the nerves proceeds forwards and

outwards through the foramen opticum, where it is surrounded by the recti muscles, and having reached the posterior surface of the globe of the eye, pierces the sclerotic coat, after which it passes through the choroïd, and finally becomes continuous with the retina.

A considerable difference of opinion exists concerning the disposition of the fibrillæ of the optic nerve at their commissure. Some of the earlier anatomists supposed that they were merely applied one to the other without any actual admixture of their substance; this opinion has now no supporters. Several physiologists are of opinion that a decussation between the nerves of opposite sides takes place, the fibres of that on the right side passing to the left, and vice versâ. Others, on the contrary, contend that the decussation, or crossing, exists only to a certain extent, being confined to the fibres on the inner side of each nerve, the rest passing on uninterruptedly. The anatomical examination of the fibrillæ, after the nerves have been macerated in dilute nitric acid, seems to indicate that those on the external border of each of them proceed forwards without admixture, but that several pass obliquely inwards through the commissure, and afterwards form part of the fibres which proceed to the eye of the opposite side: this at least is the result of Caldani's observations. Little account can be made of conclusions deduced from experiments on animals; the quantity of injury inflicted by opening the skull, in order to divide the nerves, or their commissure, is sufficient to confound all the sensations of the animal, and render any inferences nugatory that may be drawn from them. Observations on the morbid conditions of the nerves have been adduced in support of both opinions: thus, in a case in which the right eye had been destroyed, the optic nerve was found altered and wasted back to commissure on that side, and thence to the brain at the opposite side; thus supporting the theory of decussation. Some cases have also occurred in which blindness of one eye was traced to a morbid alteration of the nerve of the opposite side, at its origin from the brain. Some other instances, however, would go to prove that the decussation is only partial. In one instance in which the eye had been destroyed, and its nerve altered in

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679. The *third pair* (*motores oculorum, par tertium*) issues from the inner borders of the crura cerebri, near the locus perforatus, and about two lines anterior to the pons Varolii. This is only the point at which the nerve issues from the cerebral substance, and becomes invested by its neurilema and a tubular sheath of arachnoïd membrane, for its fibres can be traced backwards into the grey substance within the cerebral protuberance, if the pons Varolii be removed. The nerve passes forwards, and a little outwards, to enter a canal appropriated to it in the dura mater, close by the posterior clinoïd process, at which point its serous investment leaves it, and becomes continuous with that which lines the dura mater. As the nerve proceeds forwards it lies along the external wall of the cavernous sinus, being at first placed superior and internal to the fourth, and the ophthalmic of the fifth and the sixth nerves; as it approaches the sphenoidal fissure it

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A considerable difference of opinion exists concerning the disposition of the fibrillæ of the optic nerve at their commissure. Some of the earlier anatomists supposed that they were merely applied one to the other without any actual admixture of their substance; this opinion has now no supporters. Several physiologists are of opinion that a decussation between the nerves of opposite sides takes place, the fibres of that on the right side passing to the left, and vice versâ. Others, on the contrary, contend that the decussation, or crossing, exists only to a certain extent, being confined to the fibres on the inner side of each nerve, the rest passing on uninterruptedly. The anatomical examination of the fibrillæ, after the nerves have been macerated in dilute nitric acid, seems to indicate that those on the external border of each of them proceed forwards without admixture, but that several pass obliquely inwards through the commissure, and afterwards form part of the fibres which proceed to the eye of the opposite side: this at least is the result of Caldani's observations. Little account can be made of conclusions deduced from experiments on animals; the quantity of injury inflicted by opening the skull, in order to divide the nerves, or their commissure, is sufficient to confound all the sensations of the animal, and render any inferences nugatory that may be drawn from them. Observations on the morbid conditions of the nerves have been adduced in support of both opinions: thus, in a case in which the right eye had been destroyed, the optic nerve was found altered and wasted back to commissure on that side, and thence to the brain at the opposite side; thus supporting the theory of decussation. Some cases have also occurred in which blindness of one eye was traced to a morbid alteration of the nerve of the opposite side, at its origin from the brain. Some other instances, however, would go to prove that the decussation is only partial. In one instance in which the eye had been destroyed, and its nerve altered in texture for some way, it was found that the external fibres of the diseased nerve could be traced from the commissure directly backwards to the brain at the same side, so could the external fibres of the sound nerve; thus shewing that no decussation took place between them; but the internal fibres of the diseased nerve could be traced obliquely through the commissure, and also backwards along the inner side of the opposite nerve to its origin, whilst the inner fibres of the sound nerve seemed, but not so distinctly, to cross also to the opposite side. Each of these opposing opinions, then, is borne out by observations to a certain extent, so that the advocates of them are not warranted in concluding that either is universally or even generally true. Professor Meckel supposes that the anterior or orbital parts of the nerves issue from a common point (the commissure), produced by a union of the fibres which are prolonged from the brain, and that the mode of union is not quite identical in all cases, for that, in the different other structures which are joined along the middle line, varieties in the manner and degree of their union are constantly observed to occur.

679. The *third pair* (*motores oculorum, par tertium*) arises from the inner borders of the crura cerebri, near the locus perforatus, and about two lines anterior to the pons Varolii. This is only the point at which the nerve issues from the cerebral substance, and becomes invested by its neurilema and a tubular sheath of arachnoïd membrane, for its fibres can be traced backwards into the grey substance within the cerebral protuberance, if the pons Varolii be removed. The nerve passes forwards, and a little outwards, to enter a canal appropriated to it in the dura mater, close by the posterior clinoïd process, at which point its serous investment leaves it, and becomes continuous with that which lines the dura mater. As the nerve proceeds forwards it lies along the external wall of the cavernous sinus, being at first placed superior and internal to the fourth, and the ophthalmic of the fifth and the sixth nerves; as it approaches the sphenoidal fissure it

descends so as to become inferior to the other nerves, and divides into two branches, which separately pierce the dura mater, and enter the orbit by passing between the heads of the external rectus muscle. The superior or smaller branch ascends so as to get above the optic nerve, and gives one or two ramusculi to the superior rectus muscle, the other being prolonged to the levator palpebræ: the inferior or larger branch lies beneath, and to the outside, of the optic nerve, where it divides into three branches, one of which passes obliquely inwards to the rectus internus muscle; another descends and is distributed to the rectus inferior, whilst the third, longer than either, passes forwards between the inferior and external recti muscles, and terminates in the obliquus inferior. This last branch is usually said to give off a filament, which enters the inferior and posterior angle of the lenticular ganglion. Probably it would be more correct to say, that the branch was derived from the ganglion.

680. The *fourth nerve* (*nervus patheticus; trochlearis; par quartum*) is the smallest of the cerebral nerves: it arises by two, and sometimes by three filaments, from the valve of Vieussens, immediately beneath the tubercula quadrigemina. Each nerve passes forwards on the side of the cerebral protuberance, on a level with the margin of the tentorium cerebelli, and enters an aperture in the dura mater, a little inferior and external to that of the third pair: by this it is conducted into the cavernous sinus, along whose external wall it runs towards the sphenoïdal fissure, through which it enters the orbit, at the same time passing above the third nerve. The nerve finally inclines upwards and inwards, mounting over the superior rectus and levator palpebræ, and divides into two or three filaments, which enter the superior oblique muscle, at its orbital surface.

681. The *fifth pair* of nerves (*nervus trigeminus; par quintum*) has been demonstrated by Mr. Bell to be in

structure and functions analogous to the regular or symmetrical nerves. It consists of two parts, derived from distinct origins; one communicating sensation, the other the power of motion; and the former, like the posterior roots of the spinal nerves, forms a ganglion, whilst the other passes beneath the ganglion, and unconnected with it, but unites with the third division of the nerve, soon after its exit from the skull. The fifth nerve issues from the cerebral substance, about the middle of the crus cerebelli, close to its junction with the pons Varolii: it consists of from eighty to a hundred filaments, invested by a neurilema. The filaments at the circumference receive their neurilema sooner than those of the centre, so that if the nerve be torn off, a sort of mammillary process remains, which seems as if it had been concealed in the interior of the nerve. The filaments of the nerve are divisible into two fasciculi, the anterior and smaller of which can be traced through the pons Varolii as far as the medullary fibres, which are prolonged from the corpus pyramidale upwards; hence this is a motor nerve, as being derived from the tractus motorius; the other, or larger root, inclines obliquely downwards and backwards through the pons, and is derived from the corpus restiforme, whence it partakes of the properties of the posterior roots of the spinal nerves. The nerve thus constituted passes forwards, and on the summit of the pars petrosa pierces the dura mater, and enters a canal formed for it in that membrane. The fibres derived from the posterior root expand into a gangliform plexus (*Gasserian ganglion.*) This is spread out so as to resemble a crescent, and from its anterior or convex border three branches are given off, one of which passes into the orbit, another passes forwards beneath the orbit to the face, and the third descends through the foramen ovale, to be distributed to the tongue, to the teeth, and muscles of the lower jaw. The two former communicate sensibility only to the structures in which they ramify, but the latter gives the power of motion to certain muscles, and sensibility generally to all the organs to which it is distributed; hence it is a compound nerve, and its component parts can at once be recognised by drawing the plexus or ganglion forwards, which will bring into view a nervous cord that lies beneath it on the bone, and which if traced backwards will be observed to be continuous with the anterior root of the nerve, and if followed will be found to pass through the foramen, with the third division of the ganglion, and to unite with it immediately after its exit from the skull, the mode of union being perfectly analogous to that of the anterior and posterior roots of the spinal nerves.

682. 1. The *ophthalmic* nerve is the smallest of the divisions of the ganglion: it lies beneath and to the outside of the other orbital nerves, and receives, whilst lying along the outer side of the cavernous sinus, some filaments from the sympathetic. It divides into three branches, which separately pierce the dura mater to enter the orbit through the sphenoïdal fissure. These branches, from their destinations, are called lachrymal, frontal, and nasal. The *lachrymal* branch, which is smaller than the others, and also inferior to them, passes forwards, guided by the external rectus muscle, to the lachrymal gland, to which it distributes four or five filaments, that enter at its ocular surface; some are also prolonged to the external canthus of the eye, and ramify in the orbicular muscle and integument; one or two delicate filaments are also reflected inwards to the upper eye-lid. The lachrymal nerve, near its commencement, sends downwards one or two filaments, which communicate with the superior maxillary nerve, and as it proceeds forwards, one or two delicate threads are given off, which pierce the malar bone, and anastomose with the deep temporal branches of the facial nerve. *b.* The *frontal*, which is the largest branch of the ophthalmic nerve, inclines upwards and inwards, to get between the levator palpebræ and the orbit, being at first closely connected with the fourth nerve. About midway between the summit and base of the orbit, it divides into two

branches, one lying internal to the other, but on the same plane; the *internal,* or supertrochlear branch, passes forwards to the point at which the trochlea, or pulley, of the superior oblique muscle is attached to the margin of the orbit, close to which it emerges on the forehead, lying between the muscles and the bone. It soon, however, pierces the occipito-frontalis, to which it distributes filaments, and ascends upon the forehead and arch of the skull, ramifying freely upon them. The *external,* or supra-orbital branch, passes directly forwards to the supra-orbital notch, through which it escapes on the forehead, its subsequent course and distribution being similar to those of the preceding. These nerves maintain communication with the temporal branches of the portio dura. *c.* The *nasal* branch is intermediate in size and position between the preceding nerves. Having entered the orbit, through a separate foramen in the dura mater, it passes between the two heads of the external rectus muscle, and then inclines inwards and forwards, rising over the optic nerve to reach the inner side of the orbit: whilst passing over the optic nerve it gives a small branch, that terminates in the posterior and superior angle of the lenticular ganglion; probably it would be more correct to say, that it receives from the ganglion this branch of communication. At the inner wall of the orbit the nerve divides into two twigs, one of which passes into the cavity of the nose (nasal), the other issues from the orbit beneath the trochlea, and has on that account been called the infra-trochlear branch. The nasal branch passes inwards to the cavity of the cranium, through the foramen orbitale internum anterius, and on reaching the side of the crista galli, runs forwards on the cribriform lamella, descending into the nose through its anterior foramen or fissure. In this situation the nerve lies close upon the septum narium, and divides into three or four filaments, some of which ramify in the pituitary membrane, and others are prolonged to the integument at the extremity of the nose. The external, or infra-trochlear branch, emerges from the orbit at the inner canthus of the eye, and beneath the trochlea, where it divides into filaments, which ramify in the upper eye-lid, and at the root of the nose; some of them also extending to the lachrymal sack and caruncula lachrymalis.

683. 2. The *superior maxillary nerve,* or second division of the

fifth, is intermediate in size, as well as in direction and situation, between the ophthalmic and inferior maxillary nerves. It passes forwards, and leaves the skull by the foramen rotundum, after which it crosses the spheno-maxillary fossa, and enters the infra-orbital canal, through which it is conducted beneath the floor of the orbit, and finally ramifies on the cheek and side of the face. Whilst passing across the fossa, it receives two branches of communication, sent upwards to it from Meckel's ganglion; and when arrived in its osseous canal, it sends upwards into the orbit a branch *(orbital, nervus subcutaneus malæ)* which passes forwards, and anastomoses with the lachrymal nerve, sending at the same time some twigs to the lachrymal gland, and finally, some of them are continued along the outer margin of the orbit, to be distributed to the orbicular muscle and the integument. The *posterior dental* branches, three or four in number, descend upon the tuberosity of the superior maxillary bone, and enter the foramina observable on its surface: through these the filaments descend to the alveoli of the molar teeth, in the pulp of which they ramify: one filament will be observed to run along the alveolar border of the superior maxilla, supplying the gums. Before it emerges, the superior maxillary nerve sends downwards a branch *(anterior dental)* which divides into three or four filaments, for the supply of the bicuspid, canine, and incisor teeth. At its exit from the infra-orbital foramen, the nerve is concealed by the orbicularis and levator labii superioris muscles, where it divides into a number of branches, some of which incline inwards on the nose, and communicate with the nasal branch of the ophthalmic nerve, others pass downwards upon the cheek and upper lip, and a third set incline outwards, somewhat forming a complete mesh, by their interlacement with the branches of the portio dura.

684. 3. The *inferior maxillary nerve,* the largest of the branches of the fifth, is made up, as has been said, of two portions. A few lines beneath the base of the skull, this nerve divides into two primary branches. One of these, which lies superior to the other, and also is smaller than it, soon subdivides into five offsets, which are distributed to the deep-seated muscles. The *deep temporal* branches, two in number, incline outwards, and become applied to the surface of the temporal muscle, to which most

of them are distributed; some, however, pierce its fibres and fascia, and becoming superficial, anastomose with the superficial temporal branches of the facial nerve. The *buccal* branch is longer than any of the others; it inclines downwards and forwards between the pterygoïd muscles, and reaches the surface of the buccinator muscle, on which it spreads out into four or five filaments, which communicate with branches of the facial nerve, supplying the muscles of the cheek and lips. The *pterygoïd* nerves consist of three or four branches, which are distributed to the pterygoïd muscles. The *masseteric* branch passes outwards through the sigmoïd notch in the lower maxillary bone, and supplies the muscle from which its name is derived.

The remaining division of the inferior maxillary nerve subdivides into three branches, viz. the lingual, inferior dental, and auricular. The *lingual* descends between the pterygoïd muscles for some way, where it is joined at an angle by the chorda tympani nerve, which accompanies it whilst descending inside the ramus of the lower maxillary bone, but soon parts from it, to be distributed to the submaxillary gland. The lingual nerve continues its course forwards, to reach the side of the tongue, lying between the mucus membrane and the mylo-hyoïdeus muscle. As it ascends by the side of the tongue, it gets above the sub-lingual gland, and divides into several minute filaments, which may be traced beneath the mucous membrane, gradually becoming soft and waving, until they reach the papillæ, where they terminate. The nerve, during its course, gives one or two filaments to the internal pterygoïd muscle, also some which communicate with the hypoglossal nerve, and others to the sublingual gland.

The *auricular* branch inclines outwards, to gain the interval between the condyle of the lower jaw and the meatus auditorius externus, where it divides into several branches, whilst lying deeply in the substance of the parotid gland. Some of these communicate with the facial nerve, others extend to the superficial parts of the ear, whilst a third set ascend and become subcutaneous, their ultimate filaments maintaining communications with some of the temporal branches of the facial nerve.

The *inferior dental nerve* descends between the internal pterygoïd muscle and the ramus of the inferior maxilla, protected from the action of the former by the internal lateral ligament of the articulation. After its commencement a long delicate branch (*mylohyoid*) is given off, which inclines downwards and forwards, in a groove marked for it on the inside of the ramus of the jaw. This branch rests on the inferior surface of the mylo-hyoïdeus muscle, to which, as well as to the submaxillary gland and anterior belly of the digastricus, it gives filaments. The dental nerve having entered the canal appropriated to it in the lower jaw, passes horizontally forwards about three or four lines beneath the roots of the teeth, to each of which it sends filaments, which incline obliquely upwards, and enter the foramina in their apices, to be distributed to their central pulp. When arrived opposite the foramen mentale, the nerve divides into two branches, one of which, smaller than the other, continues onwards to the symphysis of the chin, where it anastomozes with the corresponding nerve of the opposite side, and from the arch thus formed filaments ascend to supply the canine and incisor teeth. The other division of the nerve passes through the foramen, and appears on the face, where it ramifies freely on the chin and lip, its filaments communicating with those of the facial nerve.

685. The *sixth pair*, (*par sextum, abducentes*,) arises close by the central line, from the superior extremities of the corpora pyramidalia, where they join with the pons. From this point each nerve passes forwards, and upwards, to enter the cavernous sinus, by a foramen in the dura mater, where it rests against the outer side of the carotid artery, and whilst so placed receives two or three filaments of communication from the superior cervical ganglion, or rather from the carotid plexus. The nerve passes thence forwards to the sphenoïdal fissure, separated from the cavity of the cavernous sinus by its lining membrane; and on passing into the orbit runs between the two heads of the external rectus, to which it is distributed by two or three filaments, which pierce the ocular surface of the muscle.

The *seventh pair* consists of two portions, distinct in structure, origin, and function.

686. 1. The *portio mollis*, (*nervus auditorius*,) is very soft in its consistence, but not so much so as the olfactory nerve: it arises from a series of white striæ, observable on the surface of the calamus scriptorius, and soon comes into contact with the portio dura, which lies posterior to it. Both nerves proceed outwards and forwards, and enter the meatus auditorius internus, where they separate, to proceed to their respective destinations. At the bottom of the meatus auditorius the auditory nerve divides into a great number of minute filaments, which separately pierce the cribriform lamella of the bone, and arrange themselves into two fasciculi, of which one (*anterior*) enters the cochlea, the other (*posterior*) passes to the vestibule and semicircular canals. These shall be particularly described with the organ of hearing.

687. 2. The *portio dura*, (*nervus facialis; sympatheticus minor*,) arises from the sulcus between the corpora restiformia and olivaria, close by the lower margin of the pons Varolii, and forms the first of the class of respiratory nerves. It passes forwards and outwards, closely applied to the portio mollis, which is slightly hollowed, to receive it. Having reached the fundus of the meatus auditorius, the portio dura enters an osseous tube (*aqueduct of Fallopius*), through which it is conducted, in a curved direction, outwards and backwards, to the stylo-mastoïd foramen. After having passed about two lines into the canal, a small nerve (*Vidian*) becomes applied to its inferior surface, and accompanies it nearly to the point of its exit from the foramen above-mentioned. The Vidian nerve there leaves it, and passes obliquely across the cavity of the tympanum, where it assumes the name of Chorda tympani: its course and destination shall be particularly considered when treating of the gangliac system of nerves. The portio dura gives two small filaments, which enter the cavity of the tympanum, and are distributed to the stapedius and tensor tympani muscles. After having issued from the stylo-

mastoïd foramen, the portio dura is embedded in the substance of the parotid gland in the interval between the mastoïd process and the ramus of the inferior maxilla, where it sends off three small branches previously to its ultimate division.

a. The *posterior auricular* branch inclines backwards and upwards, and subdivides into two branches, one of which runs before, and the other behind the meatus auditorius externus, where they ramify chiefly in the integument. *b.* The *stylo-hyoïd* branch descends upon the stylo-hyoïdeus muscle, to which, and to the digastricus, it is partly distributed, the remainder of its filaments maintaining communication with the sympathetic nerve and the ascending branch of the cervical plexus. *c.* The *submastoïd branch* (*ramus digastricus*) inclines outwards to the posterior belly of the digastric muscle, to which it distributes the greater number of its filaments, the remainder maintaining communications with the nervus vagus and its branches.

The facial nerve, after giving off these branches, inclines forwards somewhat, still lying within the parotid gland, where its division into branches takes place, and by the connexion these branches maintain with one another, a plexus is formed (*plexus parotideus, pes anserinus*), from which branches proceed upwards to the temples, downwards to the neck, and forwards on the face. Previously to forming the plexus, the nerve, in some instances, divides into two primary branches; in others there are as many as four, or even five. The branches from the plexus, formed as above, may be divided into three sets, differing in destination and direction:

The first ascend upon the zygoma in front of the ear, accompanying the temporal artery and its branches, even to the summit of the head; posteriorly they communicate with the occipital nerves, and anteriorly they incline upon the forehead, eye-brow, and upper lid, where they interlace with the frontal nerves. The second set consists of branches which pass transversely upon the cheek and side of the face, ramifying upon the lower eye-lid, the side of the nose and the lips, where their filaments interlace with those of the second and third divisions of the fifth nerve: one of these usually runs between the parotid duct and the transversalis faciei artery. The third or descending branches run obliquely over the masseter muscle, inclining towards the base of the jaw-bone, beneath which some of them communicate with the branches of the ascending cervical nerves; but others higher up maintain a similar connexion with the third division of the fifth nerve, where it ramifies on the chin. Having stated the general plan, according to which the distribution of the facial nerve takes place, it may be observed that its filaments enter the substance of the muscles of the temple and eye-lids, those of the cheeks, lips, and nose. Now it will be recollected that these are all supplied with branches from the different divisions of the fifth nerve also, which suggests the question—Do these parts receive merely an additional quantity of the same influence by their double supply of nerves, or do they derive from these sources an influence differing not in degree, but in kind*? The question has been decided by direct experiment. If the seventh nerve be divided, the muscles it supplied lose the power of motion, but retain their sensibility; but if the fifth nerve be cut across, motion is retained, but sensibility is lost.

688. The *eighth pair of nerves* consists of three nerves, which differ in their origin, course, and distribution, and are named glosso-pharyngeal, nervus vagus, and spinal accessory. The two first arise by filaments attached in a continued series to the medullary tractus, placed between the corpus olivare and restiforme, along the side of the medulla oblongata; the third commences opposite the third or fourth cervical vertebra, and thence ascends to join the others.

689. 1. The *glosso-pharyngeal* arises by three or four filaments, which are placed immediately beneath the portio

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* *Exposition of the Nervous System, by* C. Bell.

dura, above the nervus vagus, and between the corpus olivare and restiforme. The nerve inclines outwards and forwards to the foramen lacerum posterius, where it enters a small canal formed for it by the dura mater, through which it escapes from the skull. In its transit it lies internal and anterior to the jugular vein, and soon after its exit branches of communication are given to the vagus and facial nerves, and some received from the sympathetic. In the next place, some filaments pass inwards from the nerve to the pharynx, where they contribute to form the pharyngeal plexus; after which it comes into contact with the stylo-pharyngeus muscle, along which it runs to the side of the pharynx. Its ultimate distribution takes place by three small branches, one of which will be found to enter the substance of the tongue towards its root, giving filaments to the constrictor of the fauces and the lingualis; another extends to the amygdala, contributing to form a plexus around it; and the third, after giving some filaments to the hyoglossus muscle, terminates amongst the mucous follicles on the dorsum of the tongue.

690. 2. The *nervus vagus* (*par vagum, sympatheticus medius, pneumo-gastrique*) arises immediately beneath the preceding, by eight or ten filaments, placed closely together, so as to form a flat fasciculus. The nerve inclines outwards and forwards to the foramen lacerum, through which it escapes from the cranium, being in its passage separated from the jugular vein by a spicula of bone that projects from the pars petrosa, and from the nerves which take a similar course by a tubular prolongation of the dura mater which invests it. The filaments by which the nerve arises, become aggregated into a rounded cord whilst passing through the foramen, and at the base of the skull a close communication by branches is established between it and the glosso-pharyngeal, lingual, and sympathetic nerves. In the same situation also it presents a slight elongated swelling, resembling a ganglion in colour

and consistence. As the vagus nerve continues its course along the neck, it is inclosed within the sheath of the great cervical vessels lying behind and between the carotid artery and jugular vein. When entering the thorax the nerve of the right side passes between the subclavian vein and artery, crossing the latter at right angles, and gives off a recurrent branch, which, after turning behind it, ascends by the trachea to the larynx. But at the left side the nerve descends parallel with the subclavian artery, to reach the arch of the aorta, round which the recurrent branch takes its course. After having given the recurrent branch, the vagus nerve inclines inwards and backwards, to reach the side of the trachea, where some branches are given off to form a plexus on the anterior aspect of the bronchi, and a considerable number to form another on their posterior surface (*pulmonary plexus*, *anterior* and *posterior*). At the lower extremity of the plexus four or five fasciculi will be observed to pass backwards to the œsophagus, where they unite into a single cord, which is the continuation of the vagus nerve. That of the left side lies rather in front of the œsophagus, that of the right behind it; but both are connected by filaments, sent obliquely from one to the other, so as to form a sort of mesh. Resting on the œsophagus, and closely connected with it, both these nerves enter the abdomen, through the œsophagean opening, and are distributed by numerous filaments to the surfaces of the stomach.

691. The branches of the vagus nerve, including those by which it terminates, are the following :—

a. The *pharyngeal* nerve arises from the vagus nerve, immediately after its exit from the foramen lacerum, and inclines downwards and inwards to the side of the pharynx, behind which it divides into two or three filaments, which, conjointly with others derived from the superior laryngeal and sympathetic nerves, form a plexus *(pharyngeal)* behind the middle constrictor muscle;

dura, above the nervus vagus, and between the corpus olivare and restiforme. The nerve inclines outwards and forwards to the foramen lacerum posterius, where it enters a small canal formed for it by the dura mater, through which it escapes from the skull. In its transit it lies internal and anterior to the jugular vein, and soon after its exit branches of communication are given to the vagus and facial nerves, and some received from the sympathetic. In the next place, some filaments pass inwards from the nerve to the pharynx, where they contribute to form the pharyngeal plexus; after which it comes into contact with the stylo-pharyngeus muscle, along which it runs to the side of the pharynx. Its ultimate distribution takes place by three small branches, one of which will be found to enter the substance of the tongue towards its root, giving filaments to the constrictor of the fauces and the lingualis; another extends to the amygdala, contributing to form a plexus around it; and the third, after giving some filaments to the hyoglossus muscle, terminates amongst the mucous follicles on the dorsum of the tongue.

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pposite the fourth cervical vertebra. From this point the
nerve ascends by the foramen magnum, lying between the ligamentum dentatum and the posterior roots of the spinal nerves, and having mounted into the cranium, it comes into contact with the vagus nerve, close by which it passes through the foramen lacerum, but in a separate sheath of the dura mater. At the base of the skull this nerve is connected by filaments with the two preceding nerves, as well as with the lingual and sympathetic, after which it inclines outwards and downwards behind the internal jugular vein, and through the substance of the sterno-mastoïd muscle, giving off at the same time several branches for its supply. Having emerged from the muscle at its posterior border, the nerve communicates with those which form the cervical plexus, and then continues its course obliquely downwards and outwards across the neck, until it gets under cover of the trapezius muscle, to which it is finally distributed.

693. The *phrenic nerve* (which has been already alluded to (sect. 552) when treating of the cervical nerves) arises

several filaments will be observed to pass from this plexus to the other constrictor muscles also.

b. The *descending* or *superior laryngeal* nerve passes downwards and inwards behind the internal carotid artery, and divides into two branches, both being intended to ramify in the structures of the larynx. The *external* branch passes on the side of the larynx, and gives filaments to the crico-thyroïd and thyro-hyoid muscles, and to the thyroïd gland: the *internal* one pierces the thyro-hyoid membrane, together with the laryngeal artery, and is distributed to the arytænoïd and crico-arytænoïd muscles, in which its filaments communicate with those of the recurrent or ascending laryngeal nerve.

c. Below the middle of the neck two or three filaments (*cardiac branches*) are given off, which unite with those of the superficialis cordis (a branch of the great sympathetic), and from the interlacement formed between them branches are continued down to the arch of the aorta, where they contribute to form the cardiac plexus.

d. The *recurrent*, or *inferior laryngeal* nerve, at the right side turns round the subclavian artery, to gain its posterior aspect, after which it inclines obliquely inwards behind the common carotid and inferior thyroïd arteries, to reach the side of the larynx. At the left side the nerve descends into the thorax parallel with the subclavian artery, and the recurrent passes in front of the arch of the aorta and turns behind it, inclining obliquely upwards and inwards, to reach the side of the trachea. Whilst making its turn the recurrent nerve of each side gives off some filaments to the pulmonary plexus. When arrived at the top of the trachea the recurrent gives some small filaments to the inferior constrictor of the pharynx, and then enters the cavity of the larynx, where it gives branches to the crico-arytænoïd and arytænoïd muscles, communicating at the same time with the superior laryngeal nerve.

e. The *tracheal* branches run for a short way on both surfaces of the trachea, the posterior set being much more numerous. Both form plexus (*anterior and posterior pulmonary*), from which branches pass along the bronchi to their final terminations. It has been observed that whilst the nerves run on the œsophagus they communicate by oblique and transverse branches. This interlacement is usually called the *œsophagean plexus*.

f. The terminal branches of the vagus nerves ramify on the stomach. The *left*, on reaching the cardia, spreads out into branches on the anterior surface of the viscus; some of these run along the lesser curvature, where they communicate with those of the right vagus nerve, and finally several filaments are prolonged within the folds of the lesser omentum, to join with the hepatic plexus. The nerve of the right side, after forming a plexus round the cardia, distributes branches to the posterior surface of the stomach as far as the pylorus, where it communicates with the preceding nerve, and with the coronary plexus formed by the splanchnic nerve, and finally one or two branches pass backwards, leaving the stomach altogether, and join the solar plexus.

692. The *spinal accessory* nerve arises by several filaments from the side of the medulla spinalis, commencing opposite the fourth cervical vertebra. From this point the nerve ascends by the foramen magnum, lying between the ligamentum dentatum and the posterior roots of the spinal nerves, and having mounted into the cranium, it comes into contact with the vagus nerve, close by which it passes through the foramen lacerum, but in a separate sheath of the dura mater. At the base of the skull this nerve is connected by filaments with the two preceding nerves, as well as with the lingual and sympathetic, after which it inclines outwards and downwards behind the internal jugular vein, and through the substance of the sterno-mastoïd muscle, giving off at the same time several branches for its supply. Having emerged from the muscle at its posterior border, the nerve communicates with those which form the cervical plexus, and then continues its course obliquely downwards and outwards across the neck, until it gets under cover of the trapezius muscle, to which it is finally distributed.

693. The *phrenic nerve* (which has been already alluded to (sect. 552) when treating of the cervical nerves) arises

from the third and fourth cervical nerves, and also receives a filament from the fifth. It lies at first between the rectus anticus and scalenus anticus muscles, and then on the anterior surface of the latter, over which it passes obliquely. The nerve enters the thorax between the subclavian artery and vein, and descends through that cavity in front of the root of the lung, and between the fibrous lamella of the pericardium and the reflected part of the pleura. When arrived near the diaphragm the nerve divides into several branches, some of which are distributed to the substance of that muscle, others pass through it, and descend to the solar plexus, with the filaments of which they become united. This is the proper internal respiratory nerve, and is so called to distinguish it from that long branch which descends on the serratus magnus muscle, lying on the outside of the thorax. These two nerves are alluded to in this place merely to give a connected view of the respiratory system.

694. The *ninth pair* of nerves (*lingualis; hypo-glossus*) arises by several delicate filaments placed in a continued series along the sulcus between the corpus pyramidale and olivare of each side. These filaments converge and unite as they pass forwards to the anterior condyloïd foramen, through which the nerve which they form makes its exit from the cranium. The nerve at first is deeply seated, lying posterior and internal to the sympathetic and vagus nerves, but it gradually comes forwards as it descends, and after passing between the carotid artery and jugular vein becomes more superficial than either of the nerves just mentioned, and lies a little below the posterior belly of the digastricus muscle. The nerve now inclines forwards and inwards, parallel with the cornu of the os hyoides, where it is separated from the lingual artery by the hyo-glossus muscle, at the inner border of which it ascends somewhat, and divides into several filaments,

which are distributed to the genio-hyo-glossus and lingualis muscles. At the point where the nerve makes its turn forwards it will be observed to hook round the occipital artery, and then to give off its chief branch, the *descendens noni*, which inclines downwards and inwards in front of the sheath of the vessels, and at the middle of the neck curves outwards, to form, with two branches from the cervical plexus, an inverted arch. The convexity of the arch looks downwards, and from it several long delicate filaments are given off, which descend upon the forepart of the neck, and are distributed to the sterno-hyoid and sterno-thyroïd muscles, also to the omo-hyoideus. Previously to its ultimate division the lingual nerve gives some filaments to the hyo-glossus muscle, and others to communicate with the gustatory nerve.

Dissection.—When proceeding to open the skull (the muscles having been previously dissected) it will be found convenient to saw through the external table of the bones all round, from the superciliary ridge to the occipital protuberance. When this has been done the inner table may be broken through by employing a small mallet and chisel, or a strong knife made for the purpose. After the roof of the skull is removed, the chin should be supported on a block, and the dissection proceeded with. An incision may be made along the middle line so as to lay open the longitudinal sinus, after which the dura mater may be divided by a horizontal incision carried along the whole length of one of the hemispheres, on a level with the section made in the bone. This portion of the membrane may then be drawn to the opposite side, which will expose the surface of the brain, the falx cerebri, the fissure between the hemispheres, &c. The hemisphere which is uncovered may be drawn aside so as to expose the corpus callosum, and its substance may be cut through by passing down a scalpel to a level with the corpus callosum, and then directing its edge outwards and upwards somewhat, so as to avoid entering the ventricle. The ventricle may be opened by making an incision through the corpus callosum parallel with its raphé, and everting the external portion of it. The parts within the body and anterior and posterior cornua of the ventricle being examined, the descending cornu may be traced by following the plexus choroides downwards into it, after which it can be fully exposed by making an incision through the substance of the optic thalamus down to the cornu. If the cornu ammonis be drawn outwards, the point, at which the plexus enters, will distinctly appear, and also the change presented by the pia mater, where it enters the ventricle. The greater part of the substance of the hemisphere may now be removed, and the tentorium cerebelli at the same time detached from the pars petrosa, and reflected backwards. This will expose the greater number of the cerebral nerves, with their course and relations within the cranium. Those within the cavernous sinus may be brought into view by following the third, fifth, and sixth through the foramina in the dura mater, and everting it as it is cut up.

To gain a clear view of the parts within the orbit it is necessary to remove the greater part of its roof, and the whole of its outer wall. With this intent the malar bone may be sawed through on a level with the floor of the orbit, and as far back as the spheno-maxillary fissure. The orbital plate should in the next place be cut through with a chisel along its inner third, and back to the anterior clinoïd process: this incision should be continued along the floor of the middle fossa, close to the outside of the foramen rotundum and ovale, and thence along the pars petrosa, so as to cut through the great wing of the sphenoïd bone and the squamous part of the temporal bone. When this has been done the whole may be pressed down and detached, by cutting along the base of the skull, from within outwards, the knife being inserted into the fissure thus made. These measures should first be considered, and marked out on the dried skull. A complete lateral view is thus obtained of the divisions of the fifth nerve, of all those in the sinus, as well as of the orbit.

To examine the origins of the nerves and the parts at the base of the brain, it must be detached from its situation, and inverted; but it is not necessary to repeat what has been already stated in our description of the exterior of the brain.

To expose the medulla spinalis in its entire extent it becomes necessary to saw through the broad part of the occipital bone down to the foramen magnum, and then to cut through the arches of the vertebræ at each side along the whole of the column, with a knife, or chisel and mallet, as it is both tedious and troublesome to saw them. The arches being removed, the dura mater may be laid open in its entire length, and the description of the contained parts referred to.

SECTION III.

695. THE sympathetic nerves (*nervi intercostales; nerfs de la vie organique*, Bichât) form a system by themselves, characterized by many peculiarities which distinguish them from those nervous cords which are connected with the brain and medulla spinalis. They extend from the cranium to the pelvis, lying along the vertebral column, and present a chain of ganglia connected by nervous filaments, each ganglion being considered, by most physiologists, as a special centre of nervous influence. In the infancy of anatomy the term "ganglion" was used to denote a swelling in the thecæ of tendons, and even at the present day it is not unfrequently employed in the same sense. It was subsequently applied to the knotted appearance presented by certain nerves; but of late years a considerable latitude has been given to its signification by Gall and Spurzheim, who include within its comprehension the several masses of cineritious substance inclosed within the medulla and brain, and which, according to their theory, are considered "ganglia of increase" to the formative fibres of the cerebral hemispheres. Nervous ganglia may be divided into two orders: 1. Those observable on the posterior roots of the cerebro-spinal nerves, including that of the fifth nerve, as well as the slight swelling on the nervus vagus; 2. the ganglia of the sympathetic nerves.

696. To facilitate the description of the sympathetic nerves it becomes necessary to consider them as divisible

into superior, middle, and inferior portions, corresponding with the cervical and cranial regions, the thoracic, and the abdominal. As they are symmetrical, the description of one will suffice for both. Each nerve consists, in most instances, of three cervical ganglia, twelve dorsal, five lumbar, and four sacral, with their cords of connexion. To these should be added three small ganglia in the cranium; viz. the lenticular in the orbit, the spheno-palatine, or the ganglion of Meckel, and a small one, described by Ribes, as being placed on the branch of communication between the anterior cerebral arteries. We shall commence with the first cervical ganglion.

697. The superior, or great cervical ganglion, is elongated and fusiform, so as to extend from two or three lines beneath the base of the skull, to the transverse process of the third cervical vertebra. It lies on the rectus anticus muscle, concealed by the jugular vein and carotid artery. Branches proceed from it in every possible direction, which may be arranged into sets as follows—ascending, descending, external, internal, and anterior.

a. The *ascending* set are two in number: they enter the foramen caroticum, and form round the artery a plexus (plexus caroticus), from which two or three filaments pass upwards to communicate with the sixth nerve in the cavernous sinus; one or two may also be traced along the carotid artery as far as the minute ganglion placed on the arteria communicans. A filament also ascends to the nasal branch of the ophthalmic nerve, and which appears to be that which is prolonged to the lenticular ganglion; another is said to communicate with the descending branch of the Vidian nerve. Would it not be more conformable with what obtains generally throughout the organic system of nerves, to consider the two last branches as being derived, the one from the lenticular ganglion, and escorted for a while by the fifth nerve, in order to be ultimately prolonged to the carotid plexus, so as to connect the orbital ganglion with the rest of the system? and again, to view the descending branch of the Vidian as being continued to the same point, in order to associate Meckel's ganglion, and thereby the naso-palatine ganglion, with the general system, of which in strictness they form a part?

b. The *external* branches are short, and pass outwards to the superior cervical nerves, at the points at which they appear in front of the neck.

c. The *internal* set incline obliquely inwards to the parts placed along the middle line, particularly to the pharynx, where they contribute to the formation of the pharyngeal plexus.

d. The *anterior* branches are very numerous; some of them communicate by anastomosis with the vagus, glosso-pharyngeal, lingual, and facial nerves. Others pass forwards on the external carotid artery, and accompany its different ramifications. These, from their appearance, aré called *nervi molles.*

e. The *descending* branches are divisible into two sets. The first is that by which the cervical ganglion is connected with the middle or inferior one, forming the continuation of the sympathetic nerve. It is in general a long and thin branch, but in some instances its place is supplied by two filaments running parallel. The other descending branches are two or three, which unite to form the superficialis cordis nerve.

698. The middle cervical ganglion, when it exists, (which is not always the case,) is small, and very variable in its shape. It will be found on a level with the transverse process of the fifth cervical vertebra, where it is concealed by the sheath of the great vessels. It receives the branch of communication sent down to it from the superior cervical ganglion, and gives one which connects it with the inferior. From its external side branches pass to the cervical nerves; several proceed inwards, some to the thyroïd gland, others to communicate with the recurrent nerve. Finally, from its forepart issues the middle cardiac nerve.

699. The *inferior* cervical ganglion is also variable in its form, being usually single, but sometimes double. It lies in the angle between the transverse process of the last

cervical vertebra and the neck of the first rib, close by the vertebral artery, which almost conceals it from view. It receives the communicating branch from the middle ganglion, and sends down five or six, which pass, some in front, some behind, the subclavian artery, and end in the first thoracic ganglion. Some branches pass outwards, which soon join the spinal nerves that form the axillary plexus, whilst others pass inwards, to contribute to the formation of the pulmonary plexus. Finally, the inferior cardiac nerve may be considered as its anterior branch.

700. Before we proceed to describe the thoracic portion of the nerve it may be well to conclude our notice of the cranial part, by describing the lenticular ganglion, together with the spheno-palatine and naso-palatine ganglia, and their branches. The *lenticular ganglion* lies within the orbit about midway between the optic foramen and the globe of the eye, and inclosed between the external rectus muscle and the optic nerve.

Its branches are the following:—From its anterior border from sixteen to twenty delicate filaments issue, which proceed forwards to the surface of the sclerotica, and pierce it through minute foramina. These are the *ciliary nerves:* they pass along between the choroïd membrane and the contiguous surface of the sclerotica, lodged in grooves in the latter, and on reaching the ciliary ligament they pierce it, some of them appearing to be lost in its substance, whilst others pass inwards, and ramify in the iris. In their course to the globe of the eye, the ciliary nerves are divided into two fasciculi, one above, the other below the optic nerve, the latter being the more numerous. From the posterior surface of the ganglion two branches issue, of which one passes backwards and upwards to the nasal branch of the ophthalmic nerve, and which appears to be the medium of communication between the ganglion and the rest of the gangliac system, by being prolonged to the carotid plexus; the other reflected branch is shorter than the preceding, and passes downwards and backwards to the inferior oblique branch of the third nerve.

701. The *spheno-palatine*, or *Meckel's ganglion*, lies in the pterygo-maxillary fossa, close by the spheno-palatine foramen: its branches may be divided into the following sets—ascending, descending, internal, and posterior.

a. The *ascending* branches are two, which pass upwards, and join the superior maxillary nerve previously to its entrance into the infra-orbital canal. *b.* The *descending* branches form the *palatine* nerve, which is so called from its destination. The palatine nerve passes directly down, to reach the posterior palatine canal. In its descent it in the first place gives one or two small branches, which pass behind the tuberosity of the superior maxillary bone, and are distributed to the velum palati. Whilst within the canal one or two small filaments are sent off through the nasal plate of the palate bone, and ramify in the pituitary membrane. Finally, after having passed through the canal, the nerve turns forwards beneath the arch of the palate, where it divides into two branches, which ramify in the soft structures of the palate and gums. *c.* The *internal* or *pheno-palatine* branches, four or five in number, pass inwards through the foramen, from which they take their name, to reach the nasal fossæ. Three or four of these run upon the spongy bones; the other passes obliquely downwards and forwards along the septum, and reaches the upper orifice of the posterior palatine canal, where it terminates in the *naso-palatine ganglion.* This ganglion is very small, and placed in the anterior palatine canal; it receives the branch just mentioned, and gives off one or two small filaments, which descend to the membrane of the palate. *d.* The *posterior* branch of Meckel's ganglion is called *pterygoïd*, or *vidian*, from its passing back through the pterygoïd, or Vidian canal, in the base of the process of that name. Having reached the foramen lacerum posterius, it divides into two branches, one of which inclines downwards and outwards, and enters the carotid canal, where it terminates in the carotid plexus: the other branch enters the cranium, but does not pierce the dura mater. It runs outwards and backwards beneath that membrane, lodged in a groove on the upper surface of the pars petrosa, and having passed through the hiatus Fallopii, reaches the aquæductus Fallopii, where it becomes applied to the inferior surface of the portio dura, which it accompanies to within two lines or so of its exit from the stylo-mastoïd foramen. The Vidian nerve at this point turns forwards into the tympanum, where it runs between the long process of the incus and the handle of the malleus, assuming the name of *corda tympani*. In the next place the nerve descends, and escapes through the glasserian fissure, inclining at the same time forwards and inwards, so as to come into contact with the gustatory nerve, which it accompanies along the inferior maxilla, until it approaches the submaxillary gland. When near the gland the corda tympani separates from the gustatory nerve, and descends upon that body, where it divides into filaments, forming a sort of plexus.

702. The thoracic portion of the sympathetic nerve comprises, first, a series of ganglia, twelve in number, disposed in a regular series along the heads of the ribs, and connected by short nervous cords passing from one to the other; secondly, of the plexus, formed along the middle line, for the supply of the heart and lungs by the sympathetic and vagus nerves, which present this remarkable difference, that the pulmonary plexus is formed for the most part by the vagus, the cardiac by the sympathetic nerves.

703. The cardiac plexus (*ganglion cardiacum*, Wrisberg; *plexus cardiacus*, Haller) lies between the arch of the aorta and the bifurcation of the trachea, extending from the division of the pulmonary artery to the origin of the innominata. This may be considered as the common point of union of the cardiac nerves that issue from the cervical ganglia, and the immediate source from which the different nerves proceed which supply the heart. It has been described by Scarpa in these words,—" Anastomosis illa valdé insignis, quæ inter utriusque lateris cardiacorum nervorum truncos sub aortæ curvaturâ paulo supra cor conficitur."

From this plexus three orders of filaments proceed; some pass

701. The *spheno-palatine*, or thers turn forwards.
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join the superior maxillar r of them being directed towards the
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tine nerve, which rior plexus. The *posterior coronary plexus*
nerve passes direc *ramify* on the inferior and posterior surface of the
In its descent it nd auricle. These nerves were at one time supposed
which pass be d to the arteries which they accompany; but the
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be cardiac plexus receives at its upper extremity the cardiac
b of each side, and some branches from the vagus and its
current.

The superior cardiac nerve (superficialis cordis) commences by three or four filaments from the first cervical ganglion, and usually receives one or two from the trunk of the sympathetic nerve. It descends behind the carotid artery, and at the lower part of the neck divides into three branches, of which a very small one inclines inwards, and contributes to form a plexus round the inferior thyroïd artery: some join the middle, or great cardiac nerve, whilst the remainder form with the recurrent nerve a plexus, from which branches descend to the great cardiac plexus. At the left side the nerve continues undivided until it arrives at the aortic arch, where it divides into delicate branches, the greater number of which pass behind the aorta to the cardiac plexus, whilst the remainder run in front of it to join the recurrent and anterior cardiac nerves. It should be observed, that in some instances the right nerve also reaches the thorax previously to its division. The middle cardiac nerve (*cardiacus magnus*) on the right side is the largest of the set; on the left it is sometimes wanting. It descends from the middle cervical ganglion, or from the trunk of the sympathetic, should the former be wanting, and after passing in front of the

es backwards, to reach the posterior sur-
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e anterior coronary plexus, the rest joining
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others.

The thoracic ganglia, as has been said, lie on the
ds of the ribs, covered by the pleura. Considering each of them as a centre from which branches proceed, we observe a branch of communication passing upwards to the ganglion above it, and downwards to that below it, so as to continue the series. Externally one or two filaments pass from each to the contiguous intercostal nerve, so as to connect the nerves of organic with those of animal life. The internal branches from the five first ganglia pass towards the middle line, some reaching the side of the trachea, and ending in the pulmonary plexus; others ramifying on the œsophagus and aorta. But the anterior branches from the sixth to the ninth, and sometimes to the tenth inclusively, pass obliquely downwards and inwards on the sides of the bodies of the vertebræ, and unite into a single trunk (*nervus splanchnicus major*), which passes in a slight longitudinal fissure between the fibres of the crus of the diaphragm, and terminates in the semi-lunar ganglion. The anterior branches of the tenth and eleventh unite into a small nerve (*splanchnicus minor*), which pierces the crus of the diaphragm external to the larger nerve, with which it communicates by branches, and finally terminates in the renal plexus.

The abdominal part of the sympathetic nerve consists of the semi-lunar ganglia, and the primary and secondary plexus which issue from them; and, secondly, of the direct continuation of the nerve.

backwards, and join the pulmonary plexus, others turn forwards, to gain the forepart of the aorta; but the descending set, by far the most numerous, pass to the heart itself, where they are disposed in two sets, which take the course of the coronary arteries, and are thence termed the coronary plexus. The branches of the *right*, or *anterior coronary plexus*, pass forwards between the aorta and pulmonary artery, and ramify on the right ventricle and auricle, the greater number of them being directed towards the right border of the heart, where they communicate with the branches of the posterior plexus. The *posterior coronary plexus* will be found to ramify on the inferior and posterior surface of the left ventricle and auricle. These nerves were at one time supposed to be confined to the arteries which they accompany; but the researches of Scarpa have clearly shewn that they pass away from the vessels in many places, and enter the muscular structure of the heart.

The cardiac plexus receives at its upper extremity the cardiac nerves of each side, and some branches from the vagus and its recurrent.

The superior cardiac nerve (superficialis cordis) commences by three or four filaments from the first cervical ganglion, and usually receives one or two from the trunk of the sympathetic nerve. It descends behind the carotid artery, and at the lower part of the neck divides into three branches, of which a very small one inclines inwards, and contributes to form a plexus round the inferior thyroïd artery: some join the middle, or great cardiac nerve, whilst the remainder form with the recurrent nerve a plexus, from which branches descend to the great cardiac plexus. At the left side the nerve continues undivided until it arrives at the aortic arch, where it divides into delicate branches, the greater number of which pass behind the aorta to the cardiac plexus, whilst the remainder run in front of it to join the recurrent and anterior cardiac nerves. It should be observed, that in some instances the right nerve also reaches the thorax previously to its division. The middle cardiac nerve (*cardiacus magnus*) on the right side is the largest of the set; on the left it is sometimes wanting. It descends from the middle cervical ganglion, or from the trunk of the sympathetic, should the former be wanting, and after passing in front of the subclavian artery inclines backwards, to reach the posterior surface of the aortic arch, where it terminates in the cardiac plexus. The inferior cardiac nerve arises from the last cervical ganglion, by several filaments which pass behind the subclavian artery, but afterwards cross in front of the aorta, the greater number of its filaments reaching the anterior coronary plexus, the rest joining with the preceding. On the left side the inferior cardiac nerve is larger than the others.

704. The thoracic ganglia, as has been said, lie on the heads of the ribs, covered by the pleura. Considering each of them as a centre from which branches proceed, we observe a branch of communication passing upwards to the ganglion above it, and downwards to that below it, so as to continue the series. Externally one or two filaments pass from each to the contiguous intercostal nerve, so as to connect the nerves of organic with those of animal life. The internal branches from the five first ganglia pass towards the middle line, some reaching the side of the trachea, and ending in the pulmonary plexus; others ramifying on the œsophagus and aorta. But the anterior branches from the sixth to the ninth, and sometimes to the tenth inclusively, pass obliquely downwards and inwards on the sides of the bodies of the vertebræ, and unite into a single trunk (*nervus splanchnicus major*), which passes in a slight longitudinal fissure between the fibres of the crus of the diaphragm, and terminates in the semi-lunar ganglion. The anterior branches of the tenth and eleventh unite into a small nerve (*splanchnicus minor*), which pierces the crus of the diaphragm external to the larger nerve, with which it communicates by branches, and finally terminates in the renal plexus.

The abdominal part of the sympathetic nerve consists of the semi-lunar ganglia, and the primary and secondary plexus which issue from them; and, secondly, of the direct continuation of the nerve.

705. The semi-lunar ganglia have been considered by some persons as the centre of the gangliac system. They are of considerable size, but vary very much in form. They are supported on the crura of the diaphragm, close at each side of the coeliac axis. From their circumference a great number of branches proceed, which form an extensive and intricate interlacement, called the *solar plexus*, which is placed before the aorta and spine, and above the pancreas. It will be recollected, that though it is formed chiefly by the sympathetic, it receives branches also from the vagus and phrenic nerves. The secondary plexus above alluded to consist of a number of filaments, which proceed to each of the chylopoietic viscera, following the course of their arteries, and denominated accordingly. Thus the numerous branches which accompany the hepatic artery to the liver, through the lesser omentum, constitute the *hepatic plexus*; those which proceed to the stomach form the *coronary plexus*, to the spleen the *splenic plexus*; and those which lie within the folds of the mesentery receive the name of the great *mesenteric plexus*, from which another plexus is derived, the branches of which accompany the inferior mesenteric artery. The *renal plexus* differs from the others merely in the circumstance that it is made up by the lesser splanchnic nerve, and by branches from the solar plexus: from it also is derived the *spermatic plexus*, which descends (in the male) to the testis, taking the course of the spermatic artery; and in the female passes into the pelvis, to be distributed to the ovarium.

706. The continuation of the sympathetic nerve enters the abdomen by passing beneath the ligamentum arcuatum proprius, where it rests on the psoas muscle. The lumbar ganglia vary in number, being sometimes but three, at others as many as five. They, with their branches of communication, lie along the inner border of the psoas muscle: each sends inwards branches which ramify round the aorta; and outwards, some which communicate with

the lumbar nerves. In the pelvis there are usually five ganglia, connected like the rest of the series: the last pair lie closely together in front of the coccyx; sometimes there appears to be but a single ganglion, to which both nerves converge. From the outer side of each ganglion filaments of communication pass to the sacral nerves; from the inner side several join the hypogastric plexus, which is derived chiefly from the inferior mesenteric plexus. The pelvic viscera receive an abundant supply of nerves from this interlacement.

Of the Globe of the Eye.

707. The globe of the eye is situated at the internal and anterior part of the orbital fossa, which lodges it and its appendages: its form is that of a spheroïd, slightly compressed at the four opposite points of its circumference, which correspond with the insertion of the recti muscle. The direction of the globe does not correspond with that of the orbit; the axes of the eyes are parallel with one another, whilst those of the orbits diverge considerably in front, and if prolonged backwards would decussate behind the body of the sphenoïd bone; hence as the optic nerves coincide in their direction with that of the axes of the orbits, each of them must enter the globe of the corresponding eye to the inner side of its axis, and consequently of the axis of vision. When viewed in profile the globe appears to be composed of segments of two spheres, of which the anterior is smaller and more prominent; hence, when its different diameters are compared, it will be found that the antero-posterior exceeds the others by about a line. Anteriorly the globe of the eye is in relation with the conjunctiva, which is reflected from the eye-lids upon it;—posteriorly with the vessels and nerves (optic and ciliary) which enter it, and with a quantity of adipose substance, in which it is in some measure embedded, round its circumference, with the six muscles inserted into it;—superiorly, and towards its outer side, with the lachrymal gland; and internally with the caruncula and lachrymal sack.

708. The eye is composed of concentric membranes and humours; the former are not unfrequently called coats, or tunics, but as none of them forms a complete investment the term is not so applicable as that here adopted. The membranes are the conjunctiva, sclerotica, cornea, choroïd, retina, and iris, the capsule of the crystalline lens, the hyaloïd membrane, and that of the aqueous humour.

709. The *conjunctiva (membrana conjunctiva, sive adnata)* lines the free border and inner surface of the eye-lids, from which it is reflected on the globe of the eye, so as to cover its anterior third: towards the inner canthus of the eye it forms a small crescent-shaped fold, which in the human subject is but a rudiment of the membrana nictitans of birds. Along the borders of the lids it is continuous with the skin, and by lining the *puncta lachrymalia,* forms a continued surface with the mucous membrane of the lachrymal passages and nasal fossæ. It is red and vascular on the lids, but firm and pale on the sclerotica: it becomes thin and transparent on the cornea, so much so, that some anatomists have doubted whether it extends over the entire of its surface.

710. The *sclerotica* (*cornea opaca*), firm and resistant in its texture, forms about four-fifths of the external investment of the eye, extending from the entrance of the optic nerve to the border of the cornea. Its external surface is convex, and in relation with the conjunctiva, the expansions of the muscles, and the vessels and nerves of the orbit: the internal is concave, and in apposition with the choroïd membrane, with which it is connected by vascular and nervous filaments, and by some delicate cellular tissue. Posteriorly it is pierced by a small circular aperture, for the transmission of the optic nerve, situated a little to the inner side of the axis of the globe: anteriorly it is truncated, so as to leave an aperture about six lines in diameter, but somewhat greater in the transverse than in the vertical direction. The inner edge of this aperture is slightly bevelled off, so as to allow the cornea to

be inserted into it, somewhat like a watch-glass into its case. The sclerotica is a fibrous membrane, its fibres interlacing intimately, but not assuming any assignable direction. It is thicker posteriorly than towards its anterior part; but in this latter situation it is strengthened by the tendinous expansions of the muscles, which some anatomists have considered as a distinct membrane, and denominated *tunica albuginea.* The aperture for the optic nerve is usually found to be divided by a number of septa, so as to constitute a cribriform plate, through which the pulp of the nerve may be made to ooze as if through minute pores. At its exit from the skull the nerve receives an investment from the dura mater, which accompanies it to the point at which it pierces the sclerotica, where it separates from the nerve and becomes blended with the substance of the latter membrane.

The *cornea* (*cornea pellucida*) occupies the anterior fifth of the globe of the eye, its transverse diameter being about seven lines, the vertical a little less. The anterior surface, which is convex and prominent, is in contact with the conjunctiva; the posterior is concave, and is lined by the membrane of the aqueous humour: its circumference, nearly circular in the human subject, is received within the anterior border of the sclerotica, with which it is so intimately united as not to be separable from it without long-continued maceration. Its degree of convexity varies in different individuals, and at different periods of life. It is composed of five or six concentric lamellæ, united by some connecting medium, probably a fine cellular tissue, the interstices of which contain an aqueous or serous fluid. The lamellar structure of the cornea is beautifully adapted to the functions of the eye. Were it fibrous, like the sclerotica, even though at the same time translucent, it would cause a dispersion of the rays of light, and thereby resolve them into their primitive or prismatic rays, which would necessarily produce a coloured and confused image. The effect may be readily exemplified by looking at a lighted taper through a feather: the flame will instantly appear surrounded by a halo of coloured images; and were the cornea made up of fibres woven ever so finely, the effect would be similar.

711. The *ciliary ligament* (*orbiculus ciliaris*, Haller) is a ring of light grey matter, about a line and a half in breadth, which

is attached to the inner surface of the sclerotica, just at its junction with the cornea. Externally it is united, though slightly, with the sclerotica; posteriorly with the choroïd membrane; and anteriorly with the iris, which may said to be embedded in its substance. It adheres more firmly to the choroïd than to the other textures, and by a slight effort is separated from the latter, remaining attached to the former. The ciliary arteries pass through it, and distribute some twigs to it, as do the ciliary nerves in their course to the iris. Some anatomists have considered the ciliary ligament as a ganglion in which the ciliary nerves terminate, and from which branches proceed to the iris; but no instance can be adduced in which a nervous ganglion forms the medium of union and connexion between parts in the same way that this structure does, as we find it attached to the sclerotica, and giving attachment to the iris, choroïd membrane, and ciliary processes.

712. The *choroïd membrane* is placed between the sclerotica and the retina, extending from the entrance of the optic nerve as far as the ciliary ligament. In the greater part of its extent it is connected, though loosely, to the sclerotica by minute vessels, nerves, and cellular tissue; but anteriorly the union is established through the medium of the ciliary ligament. The inner surface is in apposition with the retina, or rather with Jacob's membrane. Posteriorly the choroïd presents a foramen, with a well-defined margin, for the transmission of the optic nerve: its anterior termination requires a particular description, as some difference of opinion has existed with regard to it. The membrane consists of two lamellæ, which, though separable at the posterior, are united at the anterior part, where it becomes connected with the ciliary ligament: there it drops inwards towards the axis of the eye, and is drawn into a number of delicate folds, the aggregate of which forms a complete circle, resting, like a collar, round the border of the crystalline lens, and the anterior surface of the vitreous humour. In this manner are formed the ciliary processes, the aggregate of which has been variously named by different anatomists (*corpus ciliare, corona ciliaris*).

713. The choroïd membrane is essentially vascular in its structure, being composed of minute arteries and veins, united by cellular tissue. The arteries are divided into two sets—the long and short:

the former, two in number, pass directly forwards, after having pierced the sclerotica, lying between the latter and the choroïd, without giving branches to either; and when they reach the ciliary ligament they turn inwards, and divide into branches, which are exclusively distributed to the iris. These vessels are situated at opposite sides of the globe, nearly on a line with its axis; the external one, however, is a little above, the internal a little below it. The short ciliary arteries pierce the sclerotica nearer to the optic nerve than the long ones, and soon divide into branches, which run at first parallel with one another, and mutually send twigs of communication, so that they all freely anastomoze, particularly towards the anterior part of the choroïd, where they form a circle, consisting of a most minute interlacement of vessels. The veins are readily distinguishable from the arteries by their greater size, as well as by their peculiar arrangement. They extend from before backwards in a radiated form, describing arches as they converge to the posterior part of the eye, and form by this union three or four small vessels, which pierce the sclerotica, and open into the ophthalmic vein. As the veins of the choroïd membrane are disposed in whirls, they are usually denominated *vasa vorticosa;* they occupy for the most part the external, and the arteries the internal surface of the membrane. On this distribution of the vessels is founded the division of the choroïd into two lamellæ, of which the internal is denominated *tunica Ruyschiana,* in compliment to Ruysch, who was the first that succeeded in demonstrating its structure by injection. The inner surface of the membrane, from its villous or fleecy appearance, has been called tapetum; when minutely injected it is of a deep scarlet colour. It appears to secrete the colouring matter (*pigmentum nigrum*), which gives to the choroïd membrane of man and animals its various shades of colour.

714. The ciliary processes, formed, as has been above stated, of the anterior margin of the choroïd, are from 60 to 80 in number. The form of each lamella, or process, is triangular: one side looks forward to the iris, the other backwards to the crystalline lens and vitreous humour, with which it is in contact; the third, or shortest, is free. The processes are alternately long and short, and in their arrangement resemble the plicæ observable on the under surface

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lines, corresponding not with the pro-
between them.
tunica nervea) is placed between the cho-
vitreous humour, with which it is merely in
ends from the bottom of the eye, where it is
that of the optic nerve, forwards as far as the com-
of the ciliary processes, where it appears to terminate
and rather prominent line. Its structure is soft and
the living subject it is transparent, and so continues for
ours after death, but then becomes of a pale white colour.
the ophthalmic artery has been minutely injected, the
brane can be shewn to consist of two lamellæ, of which the
ternal is vascular, and presents several small vessels, which arise
from the centralis retina; the external is medullary. If the eye be macerated for some days in water, the medullary part of the retina can be washed away, leaving the vascular in its natural position. About two lines outside the entrance of the optic nerve may be observed in the retina a small hole and a yellow spot, first described by Soemmerring, and named by him, the one *foramen centrale*, the other *limbus luteus*. The yellow spot appears to coincide with the axis of vision: the appearance which has been called a foramen is owing to a transparent point in the retina, rather than to a perforation of its substance.

"Exclusively of the two layers here noticed, the retina is found to be covered on its external surface by a delicate transparent membrane, united to it by cellular substance and vessels. If the sclerotica be removed, and the choroïd membrane carefully torn and everted, small portions of the structure here alluded to can be detached, or a globule of air, or even of quicksilver, may be insinuated beneath it, by which means it is raised, and can be seen distinctly if held towards the light*." This is now known as *Jacob's membrane*. It cannot be said to be a part of the retina, or to consist of its medullary lamella detached by the process resorted to in the dissection of the organ; for the yellow spot of Soemmerring is never distinctly seen until Jacob's membrane is removed; and when this has been effected, we can still shew the retina to consist of its two lamellæ.

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* *An Account of a Membrane now first described*, by ARTHUR JACOB, M.D.—Phil. Trans. 1819.

716. The *iris*, which presents the coloured circle seen through the transparent cornea, resembles a partition placed vertically so as to divide, but very unequally, the interval between the cornea and the lens into two parts. The iris presents two flat surfaces and two circumferences; on the anterior surface, which is differently coloured in different individuals, may be observed two concentric rings, of which the external is broader than the internal, but not so deeply coloured: it is marked by several striated lines, which pass from the great circumference inwards to the pupil, where they seem to bifurcate. The posterior surface contiguous to the ciliary processes is covered by a dark pigment similar to that of the choroïd. When this is washed off a number of fine lines, or fibres, may be observed, with the assistance of a magnifying power, converging from the greater circumference to the pupil: these are distinct from one another in the former situation, but in the latter are blended so as to form a membranous zone.

The great circumference of the iris corresponds with the ciliary ligament, into which it may be said to be inserted; the lesser forms the border of the aperture called the pupil.

The iris is abundantly supplied with nerves from the ciliary nerves: it receives the two long ciliary arteries which pass along between the choroïd and sclerotica, and the lesser, or anterior ones, which pierce the ciliary ligament from without. These vessels approach the iris from four opposite directions, and at its greater circumference freely anastomose, so as to form the larger vascular circle of the iris. From this circle branches pass inwards, converging, and form at a little distance from the pupil another circle, by a second anastomosis. Finally, from this inner circle minute filaments pass inwards, and seem to terminate at the pupilary margin of the iris. The veins, in general, take the same course as the arteries, but the greater number open into the vasa vorticosa. The ciliary nerves, after having passed through the

anterior surface of the
of a mushroom. The intervals bet ts, which soon elude our
by a pigment similar to the pig scope.
lar, which leaves on the surface
number of dark, striated li
cesses, but the intervals b rs of the Eye.

715. The *retina* (t nour is a thin, pellucid fluid, which fills
roïd membrane and v the eye, occupying the space between the
apposition. It ext me lens. It is inclosed in a thin transparent
continuous with h secretes it in the first instance, and reproduces
mencement of ted by accident, or during operations. This mem-
by a define ly called the capsule of the aqueous humour, lines the
pulpy; i d anterior surface of the iris, but does not seem to extend
some l posterior chamber.
Wh The *crystalline lens* is situated at the union of the anterior
m with the two posterior thirds of the eye, lying behind the
surrounded by the ciliary processes, and embedded in the
itreous humour. The lens is doubly convex; but the posterior segment which is received into the vitreous humour is more convex than the anterior: the convexity of both is greater in infancy than in adult age. The greatest thickness of the lens is about two lines and half; its circumference measures from twelve to fourteen. It consists externally of a soft and homogenous substance, presenting no trace of organization; but the central part, more dense and firm, is made up of concentric lamellæ.

The lens is enclosed in a capsule, which invests it all round, but without any distinguishable adherence to it, and is thicker and firmer on the anterior than on the posterior surface. If a puncture be made in the membrane a small quantity of a pellucid fluid issues from the incision, which is termed *liquor Morgagni*. When macerated in a dilute acid, or suddenly plunged into boiling water, the capsule becomes opaque and corrugated, presenting a pale, milky appearance. The lens and its capsule are both enclosed within a duplicature of the hyaloïd membrane; or rather, after investing the vitreous humour, this membrane approaches the circumference of the lens, where it may be conceived to divide into two lamellæ, of which one passes before, the other behind that body. By this arrangement an interstice of a triangular form is left, the apex of which is at the point of division of the membrane, the base at the margin of the lens; and as this is continued all round, it forms a canal, named the *canal of Petit*. When distended with air, which can be easily done by puncturing it, and inserting the point of a blowpipe, it presents the appearance of a chain of minute vesicles disposed round the lens, communicating freely, inasmuch as the air passes from one to the other.

The capsule of the lens receives a minute branch from the arteria centralis retinæ, which ramifies on its posterior segment, but none of its branches have ever been found to extend to the substance of the lens. The lens has been supposed to be muscular in its structure, and thereby to possess the power of altering its form, so as to adapt the eye to the different distances within which distinct vision obtains. This opinion was first promulgated by Dr. Pemberton*, in a thesis written at Leyden. Dr. Young† brought it forward again some years ago, and several physiologists have assented to it. Chemical analysis, however, has long since shewn that the lens consists of pure albumen, some gelatine, and water, without the slightest admixture of fibrine, the essential constituent of muscle. Moreover, were it muscular, it must consist of fibres of some sort; and were these ever so minute, or so fine, the density of the points corresponding with the fibres must be greater than that of the intervals, for intervals there must be where there are striæ, or lines, and to suppose a muscle without lines and intervals, is to suppose what has not yet been seen in nature. Were such a structure as this made a medium for the transmission of light, the rays must be dispersed and resolved into their primitive or prismatic rays, producing of necessity a coloration of the image and indistinctness of vision. The remarks and the experiment above cited, to shew that the cornea must be homogeneous, apply with equal force to the structure of the lens.

719. The *vitreous humour (corpus vitreum, humor vitreus)* fills up the posterior two-thirds of the globe of the eye. It consists of gelatinous transparent fluid, enclosed in a fine membrane (*hyaloïd membrane*), which not only invests it externally, but

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* HALLER, *Disputationes Anatomicæ*, tom. vii.

† *Phil. Trans.* 1809.

forms a number of processes, which pass inwards, and divide it into detached masses, which may thus be said to be lodged within the areolar intervals of the membrane.

Dissection.—The eye should be examined whilst fresh, as the humours soon become putrid, and the membranes alter in consistence and other properties. The eyes of animals will answer sufficiently well in the first instance; but the relative proportions of the different parts must be studied in the human eye before operations can be attempted with safety. In order to obtain correct notions of the situation and relation of the various structures, it is necessary to make several sections of the globe. Thus a verticle section, by dividing it into two equal parts, will shew the relative extent of the cornea and sclerotica, their mode of connexion. and the varying thickness of the latter in different parts. If it be suspended in water, the relation of the iris to the ciliary processes may be observed, and also the manner in which the latter are continuous with the choroïd membrane. If a transverse section be carried through the coats, and the posterior half of them be removed, leaving the vitreous humour resting on the anterior one, that disposition of the ciliary processes may be distinctly seen by which they are aggregated together so as to form a complete circle round the lens. When the ball of the eye is firmly compressed the fluid within the lamellæ of the cornea is made to ooze out on its surface, and that membrane becomes opaque. This fact shews the propriety of the practice of evacuating the aqueous humour, in certain cases, when during the progress of acute inflammation of any of the structures this indication of over distension is presented. The structure of the choroïd membrane can be examined with most effect after the vessels have been filled with some fine injection, either from the internal carotid or ophthalmic artery. The size injection will answer sufficiently well for ordinary purposes, but a solution of isinglass, tinged with indigo, will run much more minutely. In order to proceed with the examination, the forepart of the eye should be fixed: for this purpose a pin may be passed across the cornea, and the ends of it be secured to a small plate of glass by a thread, or cord. To keep the eye steady it will be found useful to affix to the glass a lump of common wax, on the top of which the eye may be secured as above-mentioned. Two incisions may then be carried over the ball of the eye, decussating with one another at the optic nerve, and thereby dividing the sclerotica into four eliptic segments. When these are everted they can be detached, and the choroïd exposed.

In order to exhibit the retina the eye should be fixed, and the same incisions made through the sclerotica. The apparatus may then be immersed in a bowl of water, in order that the humours may be supported when the exterior membranes are removed. But in separating the choroïd two pair of forceps should be used, one being employed to pinch up and hold a small portion of it, whilst it is torn with the other. This process may be continued until the whole of the vascular membrane is detached and everted, leaving the retina fully exposed.

The Appendages of the Eye.

720. The appendages of the eye comprise the eye-brow and eye-lids, the lachrymal apparatus, the muscles of the orbit, the opthalmic artery and vein, with the nerves. The *eye-brow* is the arched ridge which surmounts the upper border of the orbit, extending from near the root of the nose to the temple. It consists of integument rather thickened, and giving insertion to short hairs which are inserted obliquely into it, also of a lamella of adipose tissue, and of the orbicular and corrugator supercilii muscles. The *eye-lids* (*palpebræ*) are two thin moveable curtains placed in front of the eye, and calculated to conceal it, or leave it exposed, as occasion may require. The upper lid, which is larger and more moveable than the other, has a muscle exclusively intended for its elevation, whilst the lower one is raised up only by the action of the inferior half of the orbicular muscle. Externally the lids are covered by integument, which is thin and delicate; internally they are lined by the conjunctiva, which is more vascular than where it passes over the ball of the eye. Between these

tegumentary membranes, are placed the fibres of the orbicular muscle in both lids, and those of the levator palpebræ in the upper one, together with the tarsi, and along the margins of the lids the eye-lashes.

721. The *tarsi* are two thin lamellæ of fibro-cartilage, placed one in each lid: the lower cartilage is narrow, elongated, and nearly of equal breadth from side to side; that of the upper lid is broad at the middle, but narrows to a point at the lateral margins. The ciliary, or contiguous, margins of the tarsi are rather thick, and covered by the conjunctiva, where it is being continuous with the external tegument, but the opposite margins are thin and attached to the orbit through the medium of a thin cellulo-fibrous lamella, prolonged obliquely to its border. Along the margin of each lid two or more rows of hairs are set (*cilia*, or *eye-lashes*), those of the upper lid being the longer. Between the conjunctiva and the tarsal cartilages the sebaceous follicles of the lids are placed, which are known as the *glands of Meibomius:* they are more numerous in the upper than in the lower lid, being disposed in rows that run vertically, or, in other words, transversely with regard to the direction of the cartilages: they produce a viscid secretion, which concretes after death, and can be squeezed out of the foramina of the follicles.

722. The *lachrymal apparatus* consists of the lachrymal gland and its ducts, the lachrymal sack, the puncta lachrymalia, the caruncula, and the nasal duct. The *lachrymal gland* is placed at the superior, external, and anterior part of the orbit, being close behind the external orbital process of the frontal bone. Its forms is oval, being at the same time convex on its orbital surface, where it is received, into a slight depression, in the roof of the orbit; and concave on the ocular aspect, where it rests on the globe and the external rectus muscle. It consists of two lobes of

unequal size, each being made up of a number of granules, connected together by a delicate cellular investment. From the granules minute ducts arise and issue from the anterior edge of the gland, from which they descend along the conjunctiva, usually seven in number, and open about two or three lines above the convex edge of the tarsal cartilage, at its temporal side.

723. The *caruncula lachrymalis* is a small reddish body placed at the inner angle of the eye-lids, and inclosed between the surface of the globe of the eye and the conjunctiva, which is reflected over it. Its external margin corresponds with the interval between the puncta lachrymalia: it consists of minute follicles, united by cellular tissue, and when attentively examined will be found studded with some fine hairs. Where the external margin of the caruncula is in apposition with each lid, a minute foramen will be observed (*punctum lachrymale.*) The puncta are situated where the curved and straight parts of the lids meet; they form the openings of two canals (*lachrymal ducts*) which lead into the sack, or reservoir, for the reception of the tears. The superior canal is longer than the other: if a thin bristle be passed into it, it will be found first to ascend a little, and then to turn obliquely downwards and inwards. The inferior one descends a little, and then turns inwards with a very slight ascent: both open into the external and anterior side of the lachrymal, generally by two distinct orifices, which are close together, sometimes by a common duct.

724. The *lachrymal sack* is a membranous reservoir placed in a groove formed for it in the unguis and superior maxillary bones, at the inner canthus of the eye. Its form is oval, terminating superiorly in a cul-de-sac, but inferiorly it is prolonged into a tube, and at its superior and external side receives the lachrymal ducts. The sack is crossed by the tendon of the orbicular muscle, being at the same time covered by its fibres as well as by

its reflected tendon. It is lined by mucous membrane, continuous below with that of the nasal fossæ, and above with the conjunctiva, through the medium of the lachrymal ducts; and invested externally by a thin fibrous membrane, serving at the same time as periosteum for the bones in which it is lodged. The *nasal duct* (*ductus ad nasum*) is from six to eight lines in length in the recent state, its direction being downwards, backwards, and a little outwards. Communicating above with the lachrymal sack, it terminates in the inferior meatus by an oblique slit or orifice, which is surrounded by a small fold of the pituitary membrane.

The muscles of the orbit are seven, viz. the levator palpebræ, the four recti, and two obliqui.

725. The *levator palpebræ* arises above and before the margin of the optic foramen, from which it passes forwards and outwards, mounting over the globe of the eye, and separated only from the roof of the orbit by the frontal nerve. Finally the muscle ends in a broad expansion, which curves downwards in the substance of the upper lid, to be inserted into the margin of the tarsal cartilage.

726. The four recti muscles at their origin surround the optic nerve, and at their insertion correspond with the opposite points of the globe of the eye: each of them has a double name, one being founded on its situation, the other on its action. The *rectus superior* (*attollens*) arises close by the foramen opticum, and beneath the levator palpebræ: it passes over the globe, and is inserted tendinous into the sclerotica, about two lines behind the cornea. The *rectus inferior* (*depressor*), *rectus internus* (*adductor*), and *rectus externus* (*abductor*), all arise by a common tendon, which is attached to the bony lamella that separates the foramen opticum from the sphenoidal fissure; but the external rectus has another attachment besides that to the common tendon. Its second head arises from the margin of the sphenoidal fissure, near the superior

unequal size, each being made up of a number of granules, connected together by a delicate cellular investment. From the granules minute ducts arise and issue from the anterior edge of the gland, from which they descend along the conjunctiva, usually seven in number, and open about two or three lines above the convex edge of the tarsal cartilage, at its temporal side.

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runs close by the upper border of the external rectus muscle, which guides it to the lachrymal gland, to which the greater number of its branches are distributed; some, however, pass onwards to the eye-lids, and one or two delicate vessels pierce the malar bone, to reach the temporal fossa.

b. ——— *centralis retinæ* is a very small branch, which pierces the substance of the optic nerve, and runs embedded within it until it arrives on a level with the retina, where it divides into minute branches which ramify in the anterior or vascular lamella of that membrane: a branch will be observed also to pass through the vitreous humour, and to reach the posterior surface of the capsule of the lens.

c. ——— *supra-orbitalis* ascends to get above the muscles, and in its course forwards to the supra-orbital notch lies immediately beneath the roof of the orbit. The artery mounts towards the forehead, and distributes several branches, which communicate with those of the temporal artery.

d. ——— *ciliares* are divisible into three sets; viz. short, long, and anterior ciliary arteries. The short ciliary arteries vary from twelve to fifteen in number, and will be found to inclose the optic nerve as they pass forwards to reach the posterior aspect of the sclerotica, which they pierce about a line or two from the entrance of the optic nerve. These ramify minutely in the choroïd membrane. The long ciliary arteries, two in number, lie one at each side of the globe, as they pass forwards between the choroïd membrane and the sclerotica. Each of them passes through the ciliary ligament, and divides into two branches, which by anastomosing with one another, and with the anterior ciliary arteries, form a vascular zone round the circumference of the iris. From this, minute branches pass inwards, again subdividing and anastomosing, the last circle corresponding with the margin of the pupil. The anterior ciliary arteries are derived from some of the muscular branches; they pierce the sclerotica within two lines of the margin of the cornea, and communicate with the preceding as they ramify in the iris.

e. ——— *musculares* are subject to many varieties, in course and distribution, like all muscular vessels: they supply the seven muscles of the orbit.

rectus. Between these heads is a narrow interval, which gives transmission to the third and sixth nerves, and the nasal branch of the fifth. The four recti, thus attached posteriorly, pass forwards diverging, and are inserted into the sclerotica, about the same distance from the cornea as the superior rectus.

727. The *obliquus superior* (*trochlearis*) arises about two lines from the optic foramen at its upper and inner part. From thence it proceeds towards the internal angular process, and terminates in a round tendon, which passes through a cartilaginous ring, or pulley, that is attached to the inner margin of the orbit. At this point the tendon is reflected outwards and backwards, passing between the globe and the superior rectus, to be inserted into the sclerotica, midway between the superior and external recti muscles, and nearly equi-distant from the cornea and the entrance of the optic nerve.

728. The *obliquus inferior* arises from the inferior margin of the orbit, close by the external border of the lachrymal groove. The muscle inclines outwards and backwards between the inferior rectus and the floor of the orbit, and ends in a tendinous expansion, which passes between the external rectus, and the globe to be inserted into the sclerotica, at its external and posterior aspect.

729. The *ophthalmic artery* passes forwards from the internal carotid, where it lies by the anterior clinoïd process, and enters the orbit by the foramen opticum, placed inferior and external to the optic nerve. It soon changes its direction, passing above and to the inside of the nerve, to reach the inner wall of the orbit, along which it runs, and finally terminates by branches that ramify on the side of the nose. Its branches are very numerous, being intended to supply the eye and its appendages.

a. Arteria lachrymalis is of considerable size, and passes forwards, while the artery lies to the outside of the optic nerve. It

The Ear.

The organ of hearing is divisible into three parts, viz. the external ear, or auricula, the tympanum, and the labyrinth.

731. 1. The auricula (including under that term the *pinna*, or flat part; and the *meatus auditorius*, or the tube which leads from it to the tympanum) is placed at the side of the head, behind the jaw, and before the mastoïd process. The pinna, or flat part, is of an irregularly oval form, its superior extremity being broad, the inferior somewhat elongated and narrow. Its surfaces are marked by some prominent lines and depressions, which have received particular names. The semi-circular prominent line, which runs round the border of the pinna, is called the *helix*; it may be said to commence at the centre of the concha, above the meatus externus, and to terminate at the lobule, after having passed round the margin of the ear. Within this, and as it were inclosed by it, is another curved prominence, the *anti-helix*, which begins above the concha by two slightly elevated lines, that converge and unite, to form the line that bounds the concha, and finally terminates at the anti-tragus. The *tragus* is a small triangular prominence, that projects over the anterior and external part of the auditory tube; and opposed to it stands another, which is smaller, and called, from its position, *anti-tragus*. These parts owe their form and consistence to a firm lamella of fibro-cartilage, which constitutes their basis, and upon which the integument is reflected, giving it its exterior investment. The inferior and elongated portion of the pinna is called the lobule (*lobulus*). It is soft and pendulous, and differs in structure from all the rest, as it contains no cartilage, being composed merely of a thick lamella of condensed cellular tissue, subjacent to the common integument. Between the

prominences above noticed three depressions are observable, differing very much in form and size. The helix and anti-helix are separated by a narrow groove, sometimes called *fossa innominata.* The shallow depression between the two roots of the anti-helix is termed *fossa navicularis,* whilst the deep excavation bounded by the anti-helix, and leading into the meatus auditorius, is called *concha.*

732. The muscles attached to the pinna are—*a.* The *attollens aureum* (*superior auris*), which is the largest. It arises from the temporal aponeurosis, where it expands on the side of the head, its fibres, though delicate, being broad and radiated. The muscle ends in a compressed tendon, which is inserted into the upper and anterior part of the cartilage of the ear. *b.* The *retrahens aurem* (*posterior auris*) consists usually of three fasciculi, ranged one over the other; they arise from the mastoïd process by short aponeurotic fibres, and are inserted into the back part of the concha. *c.* The *attrahens aurem* (*anterior auris*) is a narrow, fleshy, and tendinous fasciculus, which arises from the zigoma, and passes backwards, to be inserted into the forepart of the helix.

733. The *auditory tube* (*meatus auditorius externus*) leads from the concha towards the cavity of the tympanum, from which it is separated by the membrana tympani: its direction is obliquely forwards and inwards, with a slight inclination downwards, so that it describes a curve the concavity of which looks downwards. The length of the tube is about ten or eleven lines, but its lower surface measures more than the upper, in consequence of the obliquity of the membrana tympani. The meatus is made up partly of a ring of bone, about six lines long, placed between the mastoïd process and the root of the zigoma, and above the glenoïd fossa. In the adult it forms part of the temporal bone, but in infancy it is merely connected with it by membrane, and represents a narrow ring of

bone, a line or two in breadth. The cartilaginous part of the meatus externus is continuous externally with the concha, from which it is prolonged inwards, and attached by some short irregular fibres to the rough margin of the osseous ring, with which it thus forms a continuous tube.

734. The *membrana tympani* forms the inner boundary of the meatus externus, and separates it from the cavity of the tympanum. The membrane is inserted into the inner margin of the osseous tube, and is somewhat of an elliptic form, but placed so obliquely in its situation that its external surface, which is concave, looks outwards, downwards, and forwards; the internal surface, which looks to the cavity of the tympanum, is convex. The membrane consists of three lamellæ, one being proper to itself, and of a fibrous structure, the others being tegumentary membranes, reflected upon it, and derived the one from the skin, which is prolonged in the form of a cul-de-sac into the auditory tube, whilst the other is continuous with the mucous lining of the tympanum.

735. 2. The *cavity of the tympanum* is narrow and irregular in its form, and so placed in the pars petrosa that the meatus externus lies to its outside, the labyrinth to the inner side, with the mastoïd cells opening into it posteriorly, and the Eustachian tube anteriorly. Its external wall is formed almost exclusively by the membrana tympani; the internal is composed of an irregular bony lamella, in which we observe the following elevations, openings, &c. *a.* The *promontory* (*promontorium*), a rounded bony eminence, corresponding with the middle of the extent of the tympanum, if taken from before backwards. *b.* Above the promontory is situated the *fenestra ovalis*, which leads into the vestibule, but is closed by a membrane resembling in structure the membrana tympani. The greater diameter of the fenestra is directed obliquely backwards and a little downwards. *c.* Beneath the promontory, and almost concealed by it, is another aperture,

called *fenestra rotunda,* though its form rather approaches that of a triangle: it corresponds with one of the scalæ of the cochlea, and is also closed by a membrane. When we examine the circumference of the cavity we find at a point posterior and external to the promontory, and opposite to the inferior extremity of the fenestra ovalis, a small triangular bony process, called the *pyramid,* the summit of which presents a minute opening, leading to a tube (*fistula*) in its interior, that lodges the stapedius muscle. Behind and beneath the pyramid is a minute foramen (*apertura chordæ*), which gives passage to the vidian nerve as it enters the tympanum, and assumes the name of chorda tympani. At the posterior and superior part are situated two or three foramina, which lead into the interior of the mastoïd process, which is hollowed into cells partially separated by bony septa, and lined by mucous membrane prolonged from the tympanum, so that the mastoïd cells may be considered as diverticula or prolongations from the latter cavity. In the anterior part of the floor of the cavity is the glenoïd fissure, which transmits the chorda tympani nerve, the tensor tympani muscle, and lodges the processus gracilis of the malleus. Finally, at the anterior and inner part of the cavity are two orifices, with a small bony lamella (*processus cochleariformis*) interposed between them, which separates two canals into which these orifices lead: the superior or smaller one transmits the tensor tympani muscle, the other forms part of the Eustachian tube.

736. The *Eustachian tube* is about an inch and a half long, its posterior and external part being an osseous canal, the remainder composed of fibro-cartilage and fibrous membrane; its direction as it leads from the anterior and inner part of the tympanum to the fauces being forwards, inwards, and a little downwards. The osseous part narrows somewhat as it proceeds forwards; the cartilaginous, on the contrary, widens, so that the tube is con-

stricted towards the middle, but is expanded at its extremities, particularly at the guttural one, which will be found thickened and trumpet-shaped. The tube is lined by mucous membrane prolonged into it from the pharynx, which thus becomes continuous with the lining of the tympanum.

737. The bones of the ear (*ossicula auditus*) form a chain consisting of four minute pieces, extended across the cavity from the membrana tympani to the fenestra ovalis, each being articulated with the other, so that the whole chain is moveable. 1. The *malleus*, so called from some resemblance to a mallet, is the first or most external of the series, and presents a head, neck, and processes. The head or superior part is convex and round in the greater part of its extent, but presents two slightly irregular surfaces, by which it articulates with the incus. The neck is the short constricted part that intervenes between the head and the processes. The handle (*manubrium*) is an elongated process, which, when the bone is "in situ," inclines downwards and forwards, and terminates in a small rounded process, corresponding with the most prominent part of the membrana tympani, with which it is intimately connected. The short process inclines outwards at right angles, from the upper extremity of the handle, and lies in contact with the membrana tympani. The long process (*gracilis, anterior*) is thin, and ends in a point which passes into the glenoidal fissure. 2. The *incus* is so called from some resemblance in shape to that of an anvil; it has been compared also to a molar tooth; but its similitude to either is very remote. This bone lies a little behind and to the inside of the malleus; it may be considered as divisible into a body and two processes. The body, compressed and somewhat square in its form, is directed forwards and upwards, and if its anterior border be viewed in profile it will be found to present two surfaces, which meet at an angle, and are

intended to articulate with the head of the malleus. One of the processes, shorter than the other, and also superior and posterior to it, is directed towards the mastoïd cells, where it terminates in a free point; the other inclines inwards and forwards, to articulate with the os orbiculare. 3. The *os orbiculare* is exceedingly small and nearly circular, as its name implies; it is interspersed between the last described process of the incus and the head of the stapes, articulating with both. 4. The *stapes*, or stirrup-bone, is placed horizontally, with its base resting against the fenestra ovalis, and its head articulated with the os orbiculare. The base of the bone is of the same form as the fenestra ovalis, on which it rests, its upper border being convex, and the lower straight. The anterior process is shorter and straighter than the posterior, and both are slightly grooved along their inner borders, where they give attachment to a membrane that fills the interval between them. The two processes converge and meet at a narrowed part, which is sometimes called the neck, and which is surmounted by a small tubercle or head. The head inclines outwards, and presents a superficial depression, to receive the orbicular bone.

738. The muscles of the ear, like its bones above described, are the smallest in the body: there are four in all, of which three are attached to the malleus. *a.* The *tensor tympani* (*internus mallei*) arises from the upper surface of the cartilage of the Eustachian tube, and also from the contiguous border of the pars petrosa: from thence it inclines outwards and backwards in the osseous canal that runs parallel with the Eustachian tube, and becomes tendinous on entering the tympanum, where it is inserted into the short process of the malleus. *b.* The *laxator tympani major* (*externus mallei*) arises from the spinous process of the sphenoïd bone, and soon becoming tendinous, passes through the glenoïd fissure to be inserted into the pro-

cessus gracilis of the malleus. *c.* The *laxator tympani minor* is very small, and so indistinct that many anatomists have omitted it altogether: it arises from the upper border of the osseous part of the auditory tube, and descends, to be inserted into the external process of the malleus. *d.* The *stapedius* is lodged within the tube of the pyramid, from the summit of which a small tendon issues, to be attached to the neck of the stapes.

739. 3. The *labyrinth* lies internal to the tympanum, and consists of three parts; viz. the vestibule, semi-circular canals, and cochlea. The *vestibule* is a small irregular cavity of an ovoïd figure, bounded externally by that bony lamella in which we noticed the fenestra ovalis and promontory, internally by the cribriform lamella at the bottom of the meatus auditorius internus, posteriorly by the semi-circular canals, and anteriorly by the cochlea. Along its upper surface runs the aquæductus Fallopii, an osseous tube that leads obliquely outwards and backwards from the meatus internus to the stylo-mastoïd foramen, and lodges the facial and vidian nerves. The cavity is divided into two slight foveæ, or pits, one being circular, the other oval, and intended to lodge two sacculi, which inclose the expanded part of the auditory nerve. The vestibule is lined by a delicate membrane, which appears to be of the serous class, as it secretes a fine fluid (*liquor Cotunni*) which fills all the intervals left unoccupied by the expansion of the nerve. The following foramina are observable in the interior of the cavity: *a.* externally, the fenestra ovalis; *b.* internally, four or five minute holes, which transmit the auditory nerve; *c.* at its posterior and external part, five openings, which lead into the semi-circular canals, two of them opening by a common foramen; *d.* near the common orifice just mentioned is a small foramen leading into the aquæductus vestibuli, a small curved canal about four lines long, which leads outwards and backwards

to open on the posterior surface of the pars petrosa: it transmits a small vein; *e.* at the anterior and inferior part of the cavity is the opening into the cochlea.

740. The *semi-circular canals* are three in number, and are distinguished by a consideration of their position into superior or vertical, external or horizontal, and posterior or oblique. They lie behind the vestibule, each being somewhat greater than a semi-circle. The contiguous limbi of the posterior and superior canals become united for about two lines before they reach the vestibule. Each of these is lined by a fine membrane inclosing the expansion of the nerve, and at their vestibular orifice, or commencement, a slight dilatation will be observed, corresponding with a similar enlargement of the nerve.

741. The *cochlea* has been so called from some resemblance to the shell of a snail. If insulated from the rest of the bone, it would be of a pyramidal form, the base being turned to the meatus internus, the apex outwards, and a little downwards, so as to approach the horizontal part of the carotid canal. The cochlea consists of a spiral osseous tube (*lamina spiralis*) coiled round a central axis (*modiolus*). The spiral lamella makes two turns and a half from the base of the cochlea to its summit, which is called the *cupola*. From its inner surface projects a thin bony lamella, which extends about half way across its cavity, and gives attachment to a delicate membranous plate, which completes the separation of the spiral tube into two parts, called scalæ, or stairs. The separation between the scalæ is complete except at the cupola, where the osseous part of the septum is deficient, and allows a communication between them. One of the scalæ (*scala vestibuli*) commences at the vestibule, and after making its two turns and a half ends in the cupola; the other (*scala tympani*) may be said to commence at the cupola, and after making its turns round the modiolus, to end at the fenestra rotunda. The base of the *modiolus* communicates with the meatus

internus, and is pierced by minute foramina, which give admission to the filaments of the nerve, and to some small blood vessels: its summit opens into the cupola, where it is expanded, and thence termed *infundibulum.* In the scala tympani, near its termination at the fenestra rotunda, a minute foramen exists, which leads into a canal (*aquæductus cochleæ*). This canal is three or four lines long, and terminates at the posterior border of the pars petrosa, near the jugular fossa.

The parts which compose the labyrinth are lined by delicate membranes, which inclose the expansions of the nerve, and also a fluid that fills the intervals left unoccupied by the latter. The circular depression, or fovea, above alluded to in the description of the vestibule, partially lodges the sacculus vestibuli, which contains a portion of the expanded nerve, and a pellucid fluid. The oval fovea lodges the utricula communis, which is another expanded sacculus that communicates with the membranous tubes of the semi-circular canals, and also with their nerves. When the nerve reaches the fundus of the meatus internus it divides into minute filaments, which pierce the cribriform lamella, and then become aggregated into three fasciculi, which are intended to be expanded into the sacculi and the membranous tubes, and some of them also enter the base of the modiolus, and pass to the cupola, whilst others are divided with great minuteness along the scalæ.

The Nose.

742. We have already examined the nasal fossæ (p. 135), and the olfactory nerve (p. 681): it remains merely to notice the nasal cartilages. These cartilages are five in number, one being placed in the middle line, and two at each side. The middle cartilage (*cartilago septi*) is triangular in its form, and so situated that one border rests on the vomer and the maxillary bones, the upper one articulates with the perpendicular lamella of the ethmoïd bone, and the anterior border supports the integument and the lateral cartilages. The two superior lateral cartilages are of a square form, and extend down from the nasal bones, inclosed on the outside between those of the superior maxillæ, and resting towards the middle line against the middle cartilage, which serves to support them. The two inferior cartilages form the alæ nasi, and are united above with the preceding pair, posteriorly with the maxillary bones, and in front with the middle cartilage: they are thin and curved, so as to form the arch of the anterior nares.

The Skin.

743. The skin forms a general investment for the body, as the mucous membrane constitutes the lining of all those passages and tubes which communicate either directly or indirectly with the exterior. The skin is a compound structure, being made up of three lamellæ, viz. the chorium, rete mucosum, and cuticle. The *corium* or true skin (*cutis vera*, δερμα) forms the principal layer of the integument, and is also the most deeply seated: its inner surface is loose and areolar in its texture, the areolæ being similar to those of the subcutaneous cellular tissue, by which it is connected with the subjacent parts. The superficial surface, on the contrary, is compact and uniform, but at the same time presents a number of minute papillæ, which are more distinct in some parts than in others, particularly on the palms of the hands, soles of the feet, and round the mamellæ. From some similarity to the papillæ of the tongue it has been inferred (and some minute anatomical examinations have been cited to prove) that each papilla consists of a spongy elevation of the cutis, into which projects the soft and sentient extremity of a nerve inclosed in some erectile tissue. The papillary or exterior surface of the corium is covered by a thin lamella, interposed between it and the cuticle. Malpighi appears

to have been the first who examined this structure, or conceived its existence in the human integument. It has from this circumstance been termed *rete Malpighianum*, but more usually *rete mucosum*. In the negro race it is very distinct, and sufficiently so in white people to establish its existence, though some anatomists have entertained doubts of the fact. It appears to consist of a loose and partially organized layer of cellular tissue, and forms the seat of the colouring matter of the integument. The *cuticle* (*cuticula, epidermis*) forms the external lamella of the skin. The inner surface of the cuticle is smooth and uniform, being connected with the rete mucosum and corium by cellular tissue, but can be readily separated from them by decoction or maceration: the other surface presents, in some places, a number of waving eccentric lines, which make it appear, when examined with a glass, rugged and uneven. This observation appears to have led to an opinion entertained by some anatomists, namely, that the cuticle consists of scales, or lamellæ, arranged like those of fishes, or imbricated. But there is no evidence of any such arrangement on the attached surface of the membrane, which, on the contrary, is smooth and uniform; and were the cuticle so constituted, it could not contain fluids effused beneath it after vesication has taken place; for the slightest distention, by separating the imbricated lamellæ, would leave linear openings all over its surface for the escape of the fluid. It appears then to be a homogeneous lamella, destitute of vessels or nerves, and deposited upon the skin as an insensible investment.

744. The *hairs* (*crines, pili*) are accessories, or appendages, to the skin. Each hair presents a long filament of a cylindrical form, attached by a root to the skin in rather a peculiar manner. The fixed extremity of the hair pierces the skin, which forms a tubular investment for it, and is so intimately attached to it that if the hair be drawn away it will be found inclosed in a soft sheath, called its

bulb. The extremity of the hair is hollow, and a little expanded, and terminates by some minute fibrillæ, which pass out laterally amongst the subcutaneous cellular tissue; but the tube in its interior is applied upon a delicate papilla that projects from the bottom of the bulb, and fills it accurately. These are not the only means by which the hair is fixed in its situation: the cuticle dips into the orifice of the bulb for a little way, and so comes into contact with the surface of the hair, on which it is reflected and prolonged, so as to become in a manner identified with its structure.

745. The *nails* are horny lamellæ, or scales, placed at the extremities of the digital phalanges, on their dorsal aspect. The root of the nail, which is about one-fifth of its length, is thin and white, dentated at its margin, and received into a groove, or sulcus, in the corium. The external surface of the nail is convex, and marked by some slight longitudinal lines, running from behind forwards. At the posterior, or attached extremity, a small portion will be observed differing in colour from the rest, and usually called lunula, from its form. The free extremity of the nail is its thickest part, and projects for some way beyond the last phalanx of the finger. The mode of connexion established between the nail and the tegument is as follows:—The subjacent part of the cutis, thick and red, is surmounted by a number of papillæ placed in linear series on every part of it, except that beneath the lunula. The under surface of the nail is at the same time soft, and marked by linear depressions, intended to lodge the papillæ just noticed, and to become intimately connected with them. Again, the posterior extremity of the nail is received into a sulcus in the corium, which at this point is stripped of its epidermis; but the latter at the root of the nail dips into the sulcus, and becomes reflected on its upper surface, forming a smooth superficial lamella upon it. At the free extremity of the nail the epidermis, after cover-

ing the end of the finger, is reflected on its contiguous surface, becoming identified with it. Finally, as to the disposition of the epidermis along the sides of the nail, it may be observed that at the posterior part it resembles that which takes place at the root, and further forwards is reflected in the way that obtains at the free border of the nail.

THE END.

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